Reduce, Reuse, Recycle? An Examination of Factors Influencing Environmental Behavior in Denver, Colorado

Dan Kasper

University of Denver

Follow this and additional works at: https://digitalcommons.du.edu/etd

Recommended Citation
Kasper, Dan, "Reduce, Reuse, Recycle? An Examination of Factors Influencing Environmental Behavior in Denver, Colorado" (2012). Electronic Theses and Dissertations. 840.
https://digitalcommons.du.edu/etd/840
REDUCE, REUSE, RECYCLE? AN EXAMINATION OF FACTORS INFLUENCING ENVIRONMENTAL BEHAVIOR IN DENVER, COLORADO

A Thesis
Presented to
the Faculty of Natural Sciences and Mathematics
University of Denver

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

by
Daniel J. Kasper
May 2012
Advisor: Dr. Matthew Taylor
ABSTRACT

Non-recycling and non-composting of municipal solid waste have important natural resource management implications, in that they both reduce energy, water, and raw natural resource use. Responsible waste management also likely has positive climate impacts by virtue of reducing greenhouse gas emissions. Recycling and composting are pro-environmental behaviors that have been shown to be influenced by numerous socio-demographic and psychological factors. This study analyzes the correlation of a number of variables with frequency of recycling and composting in select census tracts in Denver, CO, USA, with the goals of informing waste management policy and contributing to the overall pro-environmental behavior literature. The results show that habit strength as quantified by the Self-Reported Habit Index has the strongest correlation with both recycling and composting behavior. Overall, waste management policy should focus on influencing habit formation, using literature to dissuade residents from placing plastic bags into recycling bins, and consider charging a minimal fee for recycling.
Acknowledgments

I am grateful to the University of Denver Geography Department, specifically Dr. Mike Keables, for providing me with a research grant to undertake this research. I would also like to thank my thesis committee: Drs. Andrew Goetz, Don Sullivan, and Chip Reichardt, and especially my thesis advisor Dr. Matthew Taylor. The students, faculty and staff of the University of Denver Geography Department have always been supportive and constructively critical when necessary, and for that, I am grateful. Karen Escobar was instrumental throughout my career at the University, and couldn’t have been more helpful. Most of all, I am blessed to have such an understanding and supportive partner that has endured this journey with me. Thank you Nicole.
# TABLE OF CONTENTS

ABSTRACT .......................................................................................................................... ii

Acknowledgments ............................................................................................................... iii

List of Tables ....................................................................................................................... vi

List of Figures ....................................................................................................................... viii

Chapter 1 Introduction ........................................................................................................ 1

Chapter 2 Review of Relevant Literature ........................................................................... 8
  2.1 Environmental Values ................................................................................................. 8
  2.2 Demographic Variables ............................................................................................. 11
  2.3 Concrete and Abstract Knowledge ............................................................................ 13
  2.4 Willingness to Pay Studies ......................................................................................... 14
  2.5 Social Context and Barriers to Action Studies .......................................................... 15
    2.5.1 Integrating Behavioral Factors and the Theory of Reasoned Action ................. 17
  2.6 Habits .......................................................................................................................... 20
    2.6.1 Quantifying Habits: The Self-Reported Habit Index ........................................... 23
  2.7 Modeling Behavior ..................................................................................................... 25

Chapter 3 Description of Study Area .................................................................................. 27
  3.1 Geographic Setting ..................................................................................................... 27
  3.2 Waste Management Services in Denver, CO ........................................................... 28
  3.3 Neighborhoods Surveyed .......................................................................................... 30

Chapter 4 Methods and Research Questions ..................................................................... 33
  4.1 Research Design ......................................................................................................... 33
    4.1.1 Behavioral Model ................................................................................................. 33
  4.2 Methods ....................................................................................................................... 37
    4.2.1 Data Collection Method ...................................................................................... 37
    4.2.2 The Survey Instrument ....................................................................................... 44
  4.3 Research Questions and Data Analysis ....................................................................... 49
    4.3.1 A Note on Statistical Methods and Research Goals ........................................... 49
    4.3.2 Descriptive Statistics .......................................................................................... 50
    4.3.3 Multivariate Inferential Statistics ....................................................................... 51
    4.3.4 Creating the Behavioral Model ............................................................................ 52
    4.3.5 Research Questions .............................................................................................. 54
    4.3.6 Survey Administration and Data Analysis .......................................................... 56
Chapter 5 Results and Analysis ................................................................. 58
  5.1 Survey Responses .............................................................................. 58
  5.2 Descriptive Statistics ....................................................................... 59
    5.2.1 Demographics of the Sample ......................................................... 59
    5.2.2 Waste Management Behavior ....................................................... 61
    5.2.3 NEP and SRHI Responses ............................................................. 63
    5.2.4 Responses to Questions Directly Addressing Waste Management Policy in Denver ................................................................. 67
  5.3 Multivariate Inferential Statistics ....................................................... 74
    5.3.1 Factor Analyses ............................................................................ 74
    5.3.2 Regression Analysis ..................................................................... 90
    5.3.3 Cluster Analysis .......................................................................... 95

Chapter 6 Discussion ............................................................................... 105
  6.1 Sampling and Study Design ............................................................... 105
  6.2 Descriptive Waste Management Behavior ....................................... 106
  6.3 The Behavioral Model ...................................................................... 112
    6.3.1 Variable Groupings in the Factor Analysis ................................... 112
    6.3.2 Regression Analysis and the Behavioral Models ......................... 115
    6.3.3 Comparison to Exeter Study ......................................................... 122
    6.3.4 Characteristics of (Ir)responsible Waste Managers ..................... 127
    6.3.5 Neighborhood Comparison ......................................................... 128

Chapter 7 Conclusion ............................................................................ 134

Bibliography ........................................................................................... 141

Appendices ............................................................................................ 148
List of Tables

Table 2.1 The Self-Reported Habit Index ................................................................. 24
Table 5.1 Response Rates, Total and by Neighborhood ........................................ 59
Table 5.2 Demographic Characteristics of the Sample ........................................... 60
Table 5.3 Mean Score on Self-Reported Behavioral Frequency Items .................... 62
Table 5.4 Summary Answers to “What, if anything, prevents you from composting regularly?” .............................................................................................................. 69
Table 5.5 Aggregated Answers to the Survey Question "What, if anything, prevents you from recycling regularly?" ............................................................................................................. 73
Table 5.6 Aggregate Answers to the Survey Question "What, if anything, prevents you, or whoever mows the lawn, from (grass-cycling)?" ............................................................................. 74
Table 5.7 Factor Analysis Eigenvalues and Explanatory Power of Waste Management Behavior Variables ................................................................. 75
Table 5.8 Factor Loadings for Recycling/Composting Behavior .................................. 76
Table 5.9 Waste Management Behavior Factors as Determined by Factor Analysis ...... 77
Table 5.10 Principal Component Eigenvalues and Explanatory Power of NEP Variables ................................................................................................................................. 79
Table 5.11 Factor Loadings for NEP Items ................................................................. 80
Table 5.12 Mean Scores for NEP Item Questions .................................................... 81
Table 5.13 NEP Factors as Determined by Factor Analysis ...................................... 81
Table 5.14 Principal Component Eigenvalues and Explanatory Power of Recycling Psychological Variables........................................................................................................... 82
Table 5.15 Principal Component Eigenvalues and Explanatory Power of Composting Psychological Variables........................................................................................................... 82
Table 5.16 Factor Loadings for Recycling Psychological Variables................................. 84
Table 5.17 Factor Loadings for Composting Psychological Variables............................. 86
Table 5.18 Recycling and Composting Psychological Variable Factors............................... 87
Table 5.19 Regression Analysis Results for Recycling Behavior........................................ 91
Table 5.20 Beta Weights of the Explanatory Variables in the Waste Management Behavioral Models ........................................................................................................ 94
Table 5.21 Clustering History for Recycling and Composting Behavioral Analysis............ 98
Table 5.22 Recycling and Composting Behavioral Levels of Respondent Clusters............. 99
Table 5.23 Demographic Characteristics of Waste Management Clusters...................... 101
Table 6.1 Stepwise Model of Behavioral Change Toward a Pro-Environmental Habit. 121
Table 6.2 Mean NEP Item Scores in Exeter and Denver Samples................................... 123
Table 6.3 NEP Factor Loadings in Exeter and Denver..................................................... 125
Table 6.4 Recycling Beta Weights for Exeter and Denver Studies.................................... 126
Table 6.5 Comparison of Key Cluster Variables and Neighborhood Demographics........ 132
List of Figures

Figure 1.1 Municipal Solid Waste Generation in the U.S., 1960-2009 ......................... 2
Figure 1.2 End Use of MSW in the U.S., 1960-2009 ...................................................... 3
Figure 1.3 Components of MSW by Percent, U.S. 2009 ............................................... 4
Figure 2.1 A Schematic Causal Model of Environmental Concern ............................... 9
Figure 2.2 The Theory of Reasoned Action ................................................................ 18
Figure 2.3 Conceptual Framework of Environmental Behavior ................................. 19
Figure 3.1 Denver, CO, U.S.A. .............................................................................. 28
Figure 3.2 Census Tracts of Denver, CO. Surveyed census tracts are highlighted in grey. ................................................................................................................................. 32
Figure 3.3 Census Tracts Surveyed for the Study ......................................................... 32
Figure 4.1 Behavioral Model of Waste Management in Denver, CO. ......................... 35
Figure 4.2 Parcel Maps before (Left) and After (Right) Clipping ................................. 39
Figure 4.3 Twenty Randomly Selected Parcels in the Capitol Hill Neighborhood of Denver, CO .............................................................. 40
Figure 4.4 Sample Survey Solicitation Pattern for Choosing “Adjacent” Parcel .......... 43
Figure 4.5 Revised NEP Scale ........................................................................... 47
Figure 4.6 Statistical Analysis Model for Waste Management in Denver .................. 54
Figure 5.1 Waste Management Self-Reported Behavioral Frequency in Survey Sample 61
Figure 5.2 Scores on NEP Scale Items ................................................................... 65
Figure 5.3 Self-Reported Habit Index Scores for Recycling ..................................... 66
Figure 5.4 Self-Reported Habit Index Questions ................................................................. 66
Figure 5.5 Self-Reported Habit Index Scores for Composting ............................................ 67
Figure 5.6 Desire for Free Compost Service in Denver .................................................... 67
Figure 5.7 Willingness to Pay for Composting Service ..................................................... 68
Figure 5.8 Willingness to Pay for Recycling and Trash Services ........................................ 68
Figure 5.9 Support for Waste Management as it Applies to Climate Change ....................... 70
Figure 5.10 Support for Waste Management as it Applies to Job Creation ......................... 70
Figure 5.11 Support for Waste Management as it Applies to the County Budget ............... 71
Figure 5.12 Support for Waste Management as it Applies to Personal Finance ................. 71
Figure 5.13 Recycling Frequency as a Result of Large Bins ............................................. 72
Figure 5.14 Reasons for Increased Recycling with Large Bins ......................................... 73
Figure 5.15 Recycling Methods used by Residents who are not Eligible for Home Recycling .................................................................................................................. 73
Figure 5.16 Linear Regression Line and Data Points for Recycling Behavior Regression Model .................................................................................................................. 92
Figure 5.17 Recycling Behavioral Model ........................................................................... 95
Figure 5.18 Composting Behavioral Model ......................................................................... 95
Figure 5.19 Cluster Analysis Dendrograms and Scree Plots for Recycling and Composting Behavior ........................................................................................................... 98
Figure 6.1 Recycling Behavioral Model ........................................................................... 117
Figure 6.2 Composting Behavioral Model ......................................................................... 117
Figure 6.3 Age Distribution of Denver Neighborhoods and Clusters ............................. 129
Figure 6.5 Housing Type Distribution of Denver Neighborhoods and Clusters .......... 129
Figure 6.6 Political Persuasion Distribution of Denver Neighborhoods and Clusters ... 130
Figure 6.7 Educational Attainment Distribution of Denver Neighborhoods and Clusters ................................................................................................................. 130
Figure 6.8 Homeownership Status Distribution of Denver Neighborhoods and Clusters ................................................................................................................. 131
Chapter 1 Introduction

The United States of America is the most prolific producer of municipal solid waste\(^1\) (MSW) in the world. In 2009, the U.S. produced 243 million tons of MSW, which equates to approximately 4.34 lbs/person produced per day (Figure 1.1). Consider that the next biggest producer of MSW is China, which produced 157 million tons in 2009 (UNEP 2010). With a considerably larger population (more than three times as large), China’s per capita MSW generation is dwarfed by the U.S.’s. Of the 4.34 lbs. generated, the average American recycles or composts about 1.46 pounds (33.7%) and approximately 0.52 lbs (11.9%) of the generated waste is incinerated and used to generate energy (see Figure 1.1) (EPA 2010). This means that every day, each and every American adds an average of over 2.36 pounds of garbage to landfills in the U.S. The number of landfills in the U.S. has been diminishing for decades, resulting in landfill tipping fees increasing and policy interventions such as yard waste bans to be implemented in areas across the U.S., and they are rapidly becoming overstressed. The recycling rate has more than tripled since 1980 and doubled since 1990, though it has mostly leveled off since 2000 (Figure 1.2), yet over half of the material deposited in

\(^1\) Municipal solid waste is commonly characterized as “household waste,” “trash” or garbage. It consists of everyday items such as packaging, paper goods, food scraps, bottles, plastic, appliances, batteries, etc. Note that MSW does not include industrial wastes such as construction waste, sewage sludges, or industrial waste (which nonetheless often end up in landfills). MSW also includes household-type commercial waste, such as mixed office paper and cardboard boxes from office buildings; cafeteria and classroom wastes from institutions such as hospitals, libraries, and prisons; and household-type waste from the industrial sector, such as packaging and office waste (EPA, 2010).
landfills is recyclable (EPA 2006). The result of these factors is staggering: 243 million tons of MSW were produced by Americans in 2009, with nearly 132 million tons ending up in landfills (EPA 2010).

Figure 1.1 Municipal Solid Waste Generation in the U.S., 1960-2009
Source: US EPA, 2010, p. 3
This massive amount of discarded recyclable and compostable material represents an enormous mismanagement of natural resources. Recycling and composting (MSW recovery) save significant amounts of energy, water, and of course, raw natural resources. For example, each ton of recycled aluminum saves more than the equivalent of 36 barrels of oil or 1,655 gallons of gasoline (EPA 2006); recycling one ton of paper prevents 60 lbs of air pollution (Center for Ecological Technology 2007); recycling paper results in 35% less water pollution than making it from virgin materials, and for recycling glass the pollution reduction is 50% (Blatt 2005); and 1 ton of recycled aluminum saves 4 tons of aluminum ore from being mined (Blatt 2005). These are but a few of the positive natural resource and energy effects that are realized by recycling materials\(^2\). In addition to all of this, mining raw materials such as iron (used to make steel) and aluminum, and

\(^{2}\)For a more comprehensive list of the positive effects of waste recovery, see Appendix A.
unsustainable tree-cutting often used to garner raw materials for paper production, have deleterious environmental and social effects. As Figure 1.3 shows, a significant portion of the 243 tons of material in the MSW stream in 2009 in the U.S. is recoverable. Of this, as noted above, only 33.7% was recovered through recycling and composting, and another 11.9% was incinerated and used to produce energy (EPA 2010). Waste incineration and energy production is in some ways preferable to landfilling, but it is important to note that MSW contains a large portion of plastics (and other materials that contain toxins), and when incinerated release toxic chemicals such as dioxins, despite modern pollution control systems. This type of pollution does not occur when MSW is recycled or composted, which is the primary reason why “recovery” (recycling and composting) is preferable to incineration.

![Pie chart of MSW components by percent, U.S. 2009](image)

**Figure 1.3 Components of MSW by Percent, U.S. 2009**

Source: EPA 2010, p. 6
Increasing MSW recovery rates will also help mitigate the onset of global climate change. The anaerobic decomposition of organic material in landfills is the largest producer of anthropogenic methane emissions in the United States (Blatt 2005), and methane is over twenty times as potent a “greenhouse gas” (GHG) as carbon dioxide. The EPA (2010) reported that the 82 million tons of MSW that was recycled in 2009 prevented 178 million metric tons of carbon dioxide equivalents from being emitted into the atmosphere, which had the same effect of removing nearly 33 million passenger vehicles from the road. Carbon dioxide is viewed as the most important GHG because 1) it is the most abundantly emitted GHG in the world, and 2) it has a very long residence time in the atmosphere – it can exist for upwards of 200 years. This means that the CO$_2$ emitted from today’s landfills will likely still cause increased global temperatures in the year 2200.

It is thus clear that household waste management behavior is an important issue in the United States, and simply put, the higher percentage of the waste stream that is recycled, the better. But the question remains: What can be done to increase the MSW recovery rate? One of the major difficulties in attempting to improve recycling and composting rates is that these activities are personal behaviors, which are notoriously difficult to explain or influence, due to the complex nature of the human decision making process. Myriad studies have been performed that have analyzed determinants and correlates of recycling behavior (e.g. Vining and Ebreo 1990, Jenkins et al. 2003, Barr and Gilg 2005, Seacat and Northrup 2010), while fewer have researched composting behaviors (e.g. Taylor and Todd 1995, Barr and Gilg 2005, Edgerton, McKechnie &
Dunleavy 2009). The results of these studies have been equivocal. Many theories have been posited in an attempt to delineate what factors dictate behavior (see review of relevant literature in the following chapter), but no single theory has proven able to explain behavioral variance. It is generally understood that because of the complex nature of behavioral motivations, studies of environmental behaviors should be performed on a location-by-location basis when attempting to determine motivations of specific populations (Vining and Ebreo 1990).

Recycling was chosen for this study because, in addition to resource management issues detailed above, it is a service readily available to most residents of Denver, and thus the potential for gathering data on recycling-specific behaviors is high. Also, recycling is largely seen as normative behavior (Barr and Gilg 2005), yet the recycling rate in the United States remains below 35% (EPA 2009), which is a curious pair of circumstances – *something* is preventing people in the U.S from recycling. The benefits of recycling are many, so it is important to attempt to explain what those “somethings” are.

As composting is a similar behavior (household waste management), and has similarly important resource, energy, and emissions impacts, but has not been emphasized nearly to the extent of recycling in policy nationally or locally, it is relevant to study in combination with recycling. The purpose of this study is to determine at least some of the factors that influence recycling and composting behavior in the City and

---

3 Note that I am careful not to aver that these factors are “determinants” of behavior – human behavior is simply too complex to assume that anything *determines* behavior. Potentially infinite factors lead to behavioral outcomes, and they may reside deep within temporal or psychological recesses. It is not
County of Denver and ultimately to ascertain ways to positively influence these behaviors. Various demographic, socio-economic, and behavioral factors have been considered in this study, and their impacts on behavior analyzed. In addition, a descriptive analysis of between-neighborhood differences was undertaken to lend spatially-specific weight to the research. City policymakers may benefit greatly if correlations can be made between the various factors and behavioral outcomes. Studies of this nature are commonly undertaken in an attempt to inform waste management policy decisions (e.g. Barr 2002; Edgerton, McKechnie & Dunleavy, 2010; Seacat and Northrup 2010); the Denver City government could use the results of this study to modify its policies, for example by targeting promotional efforts in an attempt to influence factors that are correlated with increased recycling and composting. Also, questions were asked of respondents that provide direct answers that can inform waste management policy. No study to date has specifically addressed recycling or composting behavior in Denver, analyzed the impact of the habit-measurement metric used in this study on recycling behavior, or studied the impact of habit strength on composting. Thus this is a groundbreaking study that can be used to inform current understanding of waste management behavior, as well as lend itself to future research that may further enhance the understanding of factors that influence these important behaviors.

---

4 The Self-Reported Habit Index (Verplanken and Orbell, 2003) was used. See Chapter 2 for details.
Chapter 2  Review of Relevant Literature

2.1 Environmental Values

The modern environmental movement is a relatively new phenomenon in American history. Its inception is generally understood to correspond to the publication of *Silent Spring* in 1962\(^5\), and to a large extent was recognized as a bona fide (and organized) movement when the first Earth Day celebration was held in 1970. The period from the late 1960s to mid- to late-1970s saw a flurry of environmental legislation passed in the United States, as well as the establishment of the U.S. Environmental Protection Agency (EPA), and general environmental awareness and activism was on the rise. Events such as the oil shocks in 1973 and 1979, as well as the Love Canal disaster in the late 1970’s helped solidify the movement. In the 1960s and 1970s, it seemed as though the general environmental attitude was shifting from what Pirages and Ehrlich (1974) termed the Dominant Social Paradigm (characterized by a technocentric and anthropocentric worldview) of Western Society to the New Environmental Paradigm (NEP) (Dunlap and Van Liere 1978), a more ecocentric worldview. Dunlap and Van Liere felt that it was important to quantify this movement in order to better measure the paradigm shift that they sensed may be occurring. In an attempt to do so, they devised a 12 question survey with the intent of measuring adherence to the NEP, and found that the

\(^5\) It could be said that a more contemporary environmental movement is currently ongoing, though it is different in nature than the one that began in the 1960’s. The movement that began in the 1950’s and 1960’s was largely based on deep ecology principles, and the modern movement can be characterized as more eco-managerial in nature.
scale could validly measure ecological worldview (1978). This was the first time that the ecological worldview was measured in a study (Dunlap et al. 2000), and many subsequent researchers set out to test the validity and predictive validity of the NEP scale.

Stern et al. (1995) tested the correlation of the NEP to recycling behavior in Fairfax County, VA. Before the analysis, the authors proposed a model of environmental concern (see Figure 2.1). The model has two basic premises: Factors located above behavior in the model are seen as its antecedents; and proximity to behavior is positively correlated with influence on behavior (i.e. commitments and intent are the strongest influence on behavior; position in social structure, institutional constraints, and incentive structures the weakest).

![Figure 2.1 A Schematic Causal Model of Environmental Concern](image)

Source: Stern et al. 1995
Stern et al. determined that the NEP was a valid measure of generalized positive environmental beliefs, and that adherence to the NEP was positively correlated to intent to engage in recycling behavior. However, they surmised that NEP beliefs were located somewhere between (and including) values and specific beliefs on the scale. Therefore, although the beliefs engendered a propensity to engage in pro-environmental behaviors (PEBs), extrinsic factors could intervene, thereby preventing the behavior from occurring. The authors ultimately decided that although environmental beliefs likely have an effect on environmental behaviors, the interaction between values, beliefs, attitudes, and behavior are complex to the point that beliefs do not entirely predict behavior.

The authors of the original NEP revised the scale in 2000 (Dunlap, Van Liere, Mertig & Jones) in an effort to contemporize the vernacular and make improvements based on criticisms of the dimensionality and predictive validity of the original scale. The new scale was deemed the New Ecological Paradigm (NEP, the original scale will henceforth be designated as the “original NEP”), and it contained 15 items, 3 more than the original 12 items. The authors tested this improved scale in 2000. The NEP was found to correlate with both support for environmental policies and self-reported PEB. In 2003, Cordano et al. tested the predictive validity of both the NEP and the original NEP, as well as some abbreviated versions of the scale. Overall, they found that all of the scales were positively correlated with intent to engage in PEB. They recommended that the choice of which NEP scale to use should be made on a study-by-study basis. Overall,
they posit that adherence to the NEP is an important antecedent of PEB, but warn that the relationship between intent and behavior is not always a causal one.

Nooney et al. (2003) tested the relationship between the NEP worldview, demographic variables, and unspecified PEBs. The authors found that the NEP worldview did not contribute substantially to behavior. They purported that, due to extrinsic influences, people do not necessarily behave according to abstract beliefs, but that an ecological worldview does predispose one to act in an ecologically sound manner. They point to the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) for an explanation of the belief-behavior gap. These theories argue that, “factual knowledge, social values, and barriers to behavior performance work along with individual attitudes to condition the performance of environmentally protective behaviors” (ibid, 766).

These studies all provide empirically based arguments for the correlation of various environmental value scales with engagement in, and intent to engage in, PEBs. However, they also indicate that there are many other factors that influence behavior.

2.2 Demographic Variables

Crafting environmental policies and streamlining pro-environmental advertising would be rendered eminently less difficult if researchers could pinpoint demographic variables that had a demonstrative effect on propensity to engage in PEB. To this end, many studies have tried to prove just that, with limited success. For example, Schahn and Holzer (1990) found that women were more apt to engage in household-related PEB (buying environmentally safe products, recycling, and conserving water). Also more
inclined to act in an environmentally friendly manner were people who were more educated, older, and of liberal political affiliation. The authors warn that despite these correlations, external factors likely contribute to behaviors.

Steel (1995) found that women were more likely to engage in PEB (recycling, environmental politics, purchasing environmentally friendly appliances) than men, as were those with more education, less political apathy, and those purporting to be politically liberal. Extrinsic factors also had an effect, which will be discussed later. Ebreo et al. (1999) found no strong correlations between demographic variables and behavior. Barr et al. (2005) found that people who were least likely to engage in PEBs (recycling, composting, energy conservation, water conservation) were generally young, male, minimally educated, politically apathetic, and did not own their own home. Conversely, the most committed environmentalists were most likely to be older, female, politically active, and homeowners.

In a meta-analysis of 128 previous studies, Hines et al. (1987) found that overall, income and educational levels were significantly related to PEB, while gender and age were not. In 1995, Shultz et al. summarized the theretofore studies of demographic effects on recycling behavior and found that women were more likely to recycle than men, and that income had a positive relationship with recycling behavior. The results gathered regarding age, education level, and ethnicity were deemed inconclusive.

Overall, most studies to date support the idea that women are more environmentally responsible than men, and that degree of adherence to a politically liberal philosophy and income level are generally positively correlated to self-reported
PEB. However, similar to the NEP research performed, none of these studies claim that demographics are the sole determinants of behavior. No sociologist or social psychologists claim that behavior is dictated by only one, or even a few, factors.

2.3 Concrete and Abstract Knowledge

Two types of knowledge are generally understood to be relevant when studying environmental behavior, which Schahn and Holzer (1990) termed abstract knowledge (AK) and concrete knowledge (CK). Abstract knowledge refers to general awareness of macro-environmental issues, such as greenhouse gas emissions, deforestation, resource depletion, biodiversity loss, etc. Concrete knowledge refers to one’s familiarity with local issues and services, such as what can be recycled, where to deposit compost, and local water use restrictions. Schahn and Holzer found that AK had no effect on PEB, but that CK exhibited a positive correlation with recycling rates. Vining and Ebreo (1990) found a strong correlation between knowledge of local recycling practices and self-reported recycling behavior, as did Barr et al. (2005). In their review of previously published literature, Schultz et al. (1995) showed that overall, CK had shown a positive relationship with recycling behavior.

These findings are intuitive – one is conceivably more likely to perform behaviors that are familiar to them. It is important to note that CK not only renders a behavior less taxing, but also enhances the perception that the behavior is easier to perform (Barr and Gilg 2005, Palatnik et al. 2005, Vining and Ebreo 1990). Abstract knowledge often has no bearing on behavior because it is not usually the only impetus for behavior. Many researchers have noted this disconnect between abstract beliefs and behavior (e.g. Ebreo
et al. 1999, Nooney et al. 2003, Schahn and Holzer 1990). Thus, CK is generally understood to be the only relevant type of knowledge in terms of PEB.

2.4 Willingness to Pay Studies

As is the case for any public service, waste removal costs money. In addition, many environmentally friendly behaviors (e.g. buying organic foods, buying natural cleaners, purchasing alternative energy sources) come at a higher cost than their environmentally “unfriendly” counterparts. Consequently, money has often been found to play a role in rates of PEB. For example, Palatnik et al. (2005) found that most survey participants exhibited a willingness to recycle, even if they would have to pay a small amount of money to do so. However, the higher the proposed cost, the less people were willing to recycle. Also, as perceived effort to recycle increased the acceptable recycling fee decreased. Overall, price was shown to have a mildly preventative effect on willingness to recycle.

Batley et al. (2000) found a similar relationship between willingness to pay (WTP) and PEB. Their study population was nearly unanimous in their support for the purchase of renewable energy, as long as the cost was no greater than non-renewable energy. Only 34% of the respondents declared their WTP if their cost was to increase, even when controlling for anthropocentric worldview and demographics. In 2005, Blaine et al. designed a study to determine if proposed method of payment (payment card or referendum) had any effect on the amount people would be willing to pay for waste removal services (the service was free at the time of the study). They found that residents were willing to pay more when considering the referendum, and that a significant
majority of respondents were willing to pay at least $1.50/month for services, even when given the option of paying less or nothing. A mere $1/month from every Denver household eligible for free recycling (approximately 160,000) would cover the entire 2007 recycling operating budget of $1.5 million (Pitt 2007).

2.5 Social Context and Barriers to Action Studies

It is generally understood that extrinsic influences have an effect on behavior, and they have often been determined as the most important influence. The presence of perceived or real inconvenience has been shown to be an important factor leading to PEB. Derkson and Gatrell (1993) determined that people who avow concern for the environment recycled at a higher rate than the unconcerned, but only if recycling was convenient (curbside recycling available). There was no difference in recycling when respondents did not have curbside recycling available. The lack of convenience was seen as a “contextual barrier to action” (p. 435) that could not be overcome. The authors contended that reducing barriers based on inconvenience was the most efficient way to increase recycling rates, and increase PEB rates in general. Vining and Ebreo (1990) arrived at a similar conclusion – specifically, that perception of the inconvenience of recycling was enough to override the ecologically sound intentions of survey respondents. In fact, recyclers and non-recyclers were found to have nearly identical levels of environmental concern. The only difference between the groups was perceived inconvenience of recycling, and CK (as noted above). The authors recommended that the best way to convince people to recycle is to increase their knowledge regarding what and how to recycle, to decrease the difficulty of engaging in recycling behavior, and to
convince them of the long-term benefits of recycling. Berger (1997) found that inconvenience was consistently a significant barrier to recycling, as did Jenkins et al. (2003). As previously mentioned, Palatnik et al (2005) found that WTP and willingness to participate in composting and recycling decreased significantly with decreased convenience. They also found that the positive impact of ecological worldview on behavior decreased with increasing perception of inconvenience. Shultz et al. (1995) cited three separate studies that determined that recycling rates were inversely proportional to distance to the nearest recycling receptacle (assumed to be a measure of convenience). Steel (1996) determined that situational variables, such as accessibility and ease of behavior, were the most important determinants of PEB (donating money to environmental organizations, signing petitions, recycling, using alternative transportation, and a host of other behaviors). Lack of opportunity, which was interpreted by the author to mean presence of inconvenience, was cited by survey respondents as the main barrier to engaging in all PEBs studied.

Corraliza and Berenguer (2000) also found that barriers to action had significant effects on PEB. They found that when one’s personal disposition favored a behavior in question and the situation (social context) is seen as facilitory, the behavior was nearly always performed. If the disposition was unfavorable, and the social context seen as inhibitory, the behavior was rarely performed. These results are not surprising. However, they also found that the behavioral result of a positive disposition combined with an inhibitory context and a negative disposition with a facilitory context was the same. Social context, it seemed, was a primary driver of behavior. Vining and Ebreo
(1999) found that recycling rates did not correlate well with other PEBs, and they also posit that this was a result of contextual barriers. More specifically, they believed that recycling was seen as a social norm, while environmentally responsible consumerism was not. The normative aspect of recycling behavior was also proposed by Barr et al. (2005) and Nooney et al. (2003).

It has thus often been found that social context and barriers to action have a significant effect on PEB rates. Most researchers agree that convenience, both real and perceived, plays a prominent role in propensity to engage in PEB. This may be due to a dearth of leisure time, laziness, or a general state of apathy among a given populace. In any case, these barriers to action are difficult to overcome.

2.5.1 Integrating Behavioral Factors and the Theory of Reasoned Action

Studies by Barr (2002) and Barr and Gilg (2005) effectively synthesized most of the concepts discussed in the aforementioned articles. Barr proposed a new model of the conceptualization of the determinants of PEB. The model is an expansion of the Theory of Reasoned Action (Fishbein and Ajzen 1975), which is a highly respected and oft-used general model of behavior. The Theory of Reasoned Action posits that behavior is determined by behavioral intention, which is predicated on attitude towards the behavior and subjective norms. Attitude is dependent on anticipated consequences of the behavior in question and the evaluation of those consequences, while subjective norms are comprised of the recognition of the norms to act, and the acceptance of these norms (Figure 2.2).
Barr expanded this model considerably, and adapt it specifically to study PEB (Figure 2.3). In his model, behavior is affected by “situational variables” (SV), “behavioral intention” (BI), and “psychological variables” (PV) (2005, 231). Behavioral intention is influenced by SV, PV, and environmental values (ecocentricity or anthropocentricity). The situational variables are behavioral context, socioeconomic variables, knowledge (AK and CK), and personal experience. Psychological variables are: Altruistic influences, intrinsic motivation, extrinsic motivation, perception of problem, perception of environmental threat, response efficacy (the awareness of the consequences of behavior), subjective norms, perceived difficulty of behavior, and environmental citizenship (the feeling of being part of society and the natural environment). Note that some of these variables were based on the Theory of Planned Behavior (Ajzen, 1991) (from Barr, 2002), which added “perceived behavioral control” to the TRA. Perceived behavioral control relates to the belief that a behavior is convenient and under one’s control (de Bruijn, 2011).
The authors used this model to analyze self-reported behavior, and willingness to engage in PEB, with a focus on recycling (though other PEBs were considered). They found that perceived convenience was the most important factor in reported behavior, while knowledge of local waste policies (CK) and access to a curbside recycling bin (convenience) were significant to a lesser degree. It is important and perhaps surprising to note that the expressed willingness to recycle and self-reported recycling behavior were significantly different. Only ten percent of those surveyed were “very unwilling” to recycle, but thirty percent said that they “never recycled” most items, which demonstrated a significant value-action gap (p. 237). Willingness to recycle was predicted mainly by environmental concern, norm acceptance, logistical issues, perceived convenience, and concrete knowledge; whereas actual behavior was only affected by concrete knowledge, perceived convenience, and actual convenience.
The authors also determined that other waste prevention behaviors\textsuperscript{6} were undertaken to a significantly lower degree than recycling. They proposed that this was likely due to recycling being a normative behavior, and waste prevention not being normative in nature. The authors concluded that recycling is not the result of ecological worldview, a true commitment to recycling, or the normative nature of recycling behavior; and that factors facilitating recycling are different than those that determine other PEBs. They recommend that the most effective way to increase recycling rates are to increase actual convenience (more curbside availability), perceived convenience (perhaps a “recycling is easy” campaign), and clarifying knowledge of where and when to recycle. These recommendations are based on the results of the analysis of all the behavioral influences in the model (Figure 2.3). The model is very holistic, taking into consideration most perceivable factors that may influence PEB. As will be seen below, the research structure in this report is largely based on this model created by Barr (2002).

2.6 Habits

Habits are most commonly associated with recurrent behavioral, as in “a habitual liar,” or “a habitual flirt.” Most commonly, these statements imply frequency of behavior. However, in a sociological or psychological context habits have a deeper connotation, as adequately summarized by Verplanken and Aarts (1999). They state that habits are “learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states” (p. 104). They are mostly subconscious, automated decision-making tools that have been proven to achieve

\textsuperscript{6} Other behaviors studied included composting, reusing items, bringing a reusable bag to the grocery store, and fixing an item instead of buying a new one.
certain goals, and are performed in reaction to environmental cues. Humans’ lives are rife with habitual behavior – looking both ways before crossing the street, brushing one’s teeth before bed, exercising, smoking – all of these behaviors are performed in response to specific environmental or internal cues. The role of habits in explaining behavior has traditionally received less attention than more conscious processes, as demonstrated by the predominant behavioral theories of the past few decades, such as the Norm Activation Model (Schwartz 1977), the Theory of Reasoned Action (Ajzen and Fishbein 1980), and the Theory of Planned Behavior (Ajzen 1991). There are many possible explanations of habit formation, such as freeing the mind for more complex tasks, and simplifying the enormous amount of information people receive on a daily basis (Biel 2003, Verplanken and Orbitt 2003). Whatever the reason, habits have been shown to have powerful influence over behavior and behavioral intention.

Bamberg and Schmidt (2003) studied the role of habits and other behavioral correlates (subjective norms, intention, attitude, perceived behavioral control) in making transportation choices. They found that the strongest predictor of actual behavior was habit. The role of habit was even stronger than behavioral intention, which is largely seen as having the most direct influence over behavior (e.g. Ajzen and Fishbein 1980, Ajzen 1991, Taylor and Todd 1997). Similar results were obtained by Verplanken (2005), Verbecke and Vackier (2005), and Honkanen et al. (2005), albeit in studies of eating habits. All of these studies determined that habits have a very strong influence over behavior.
Dahlstrand and Biel (1997) studied the implications of varying habit strengths of PEB in the form of purchasing environmentally-friendly cleaning products. Based on survey responses, they divided their subjects into three groups, each with different overall level of habit strength, and examined common characteristics of members of each group. Each group differed from the others in terms of many different characteristics, including belief in effectiveness of products, environmental, sensitivity to price, perceived difficulty of behavior, and others. Discerning these groups’ psychological characteristics has important policy implications – it shows that people may respond to distinct types of information depending on their habit strength (this finding is corroborated by many studies – e.g. Oullette and Wood 1998, and Biel 2003). If a correlation can be made between habit and behavior, and correlates of these habits can be delineated, it provides another set of possibilities to increase incidence of desired behavior. Also, a strong correlation between habit and behavior would open the door to habit-modification as a viable method of changing behavior (Biel 2003).

A few more recent studies have attempted to shed some light on the influence that habit has on waste management behavior, focusing on recycling. Knussen and Yule (2008) analyzed surveys they administered to individuals near Glasgow, Scotland. After controlling for demographic and TPB-related characteristics, the authors found that (lack of) recycling habit played a significant role in intention to recycle. Self-reported habit was found to mediate the attitude-intention relationship, diminishing the influence that attitudes had on intention. Klöckner and Oppedal (2011), in a study of Norwegian college students, found that recycling habit exhibited a stronger influence on self-reported
recycling behavior than both intention and perceived behavioral control. Notably, neither personal norms, social norms, nor attitude were found to significantly influence recycling behavior.

2.6.1 Quantifying Habits: The Self-Reported Habit Index

The results of these studies indicate that a measurement of habit should be included in any examination of psychological factors that influence behavior. Of course, to determine habit strength, one must utilize a reliable metric. Traditionally, most studies have used researcher-derived scales that measure frequency of past behavior (see Dahlstrand and Biel 1997, Oulette and Wood 1998, Biel 2003, Verplanken and Orbell 2003, and Knussen and Yule 2008). However, as explained above, habit is not entirely analogous to behavioral frequency, though recurrence of behavior may lead to habit formation (Verplanken and Orbell 2003). Habits are psychological constructs with a number of facets, and therefore cannot be explained entirely by behavioral frequency.

Verplanken and Orbell (2003) set out to determine a reliable habit measuring tool based on extensive research of published studies of the elements of habitual behavior. The key elements they derived for this metric are: difficulty of controlling the behavior, lack of awareness of performing the behavior, and perceived efficiency of the behavior (these are seen as the “automaticity” element of habits); history of repetition of the behavior; and the “identity element” (p. 1317). These constructs are intuitive, with perhaps the exceptions of identity, which the researchers proposed because “habits are part of how we organize everyday life and thus might reflect a sense of identity or personal style” (p. 1317); and efficiency, which the authors stated would be particularly
apparent under “conditions of heavy load, such as exhaustion, time pressure, distraction, or information overload” (p. 1317). As mentioned previously, habits are perhaps formed to cope with various daily stressors. They hold that the identity construct should be relevant to many, but not all, behaviors. They termed this scale the Self-Report Habit Index (SRHI), which is made of twelve items (see Table 2.1). The authors subsequently tested the SRHI on four separate studies, which assessed a variety of behaviors, including transportation choices, eating habits, and television watching habits. They found the scale to be psychometrically reliable, valid, and unidimensional. The SRHI has been successfully used by other researchers, including Honkanen et al. (2005) and Klöckner and Oppedal (2011) (the latter used a modified version). To date, only Klöckner and Oppedal have used the SHRI to analyze recycling behavior, but none have utilized it in research relating to composting behavior.

**Table 2.1 The Self-Reported Habit Index**

Behavior X is something…
I do frequently
I do automatically
I do without having to consciously remember
that makes me feel weird if I do not do it
I do without thinking
that would require effort *not* to do
that belongs to my daily routine
I start doing before I realize I’m doing it
I would find hard not to do
I have no need to think about doing
that’s typically “me”
I have been doing for a long time

*Source: Verplanken & Orbell (2003)*
2.7 Modeling Behavior

Human behavior is extremely complex – despite the best efforts of experts in relevant fields of study over decades, behavior cannot be predicted. However, the literature demonstrates that statistically significant correlations can be made between antecedent variables and behavioral outcomes, and these relationships can be useful to policymakers and those who wish to better understand behavioral influences. A review of the relevant literature provided a comprehensive list of potential variables and behavioral models that this study could be based on. I took into account all of the research and derived a questionnaire and model that incorporates nearly all of the variables in the research described above. The resulting survey instrument is described in Chapter 4.

2.8 A Note on Geographical Context

Stewart Barr notes that environmental action is “quintessentially a geographic topic” (2006, p. 44), though research regarding environmental action has been traditionally limited to social psychology. Barr gives no further explanation for this assertion, but Richard Peet provides insight when he states that “Geography is the study of relations between society and the natural environment” in his seminal work *Modern Geographical Thought* (1998, p. 1). The implication of these two statements is that – arguments against a human-nature dichotomy aside – investigation of environmental behavior is geographic *ipso facto* because it involves the relationship between spatially distinct elements. Namely, the self on one hand, and “nature” on the other. This is also

---

7 Recycling and composting, having significant environmental impacts, are environmental actions.
expressed by Amadeo and Golledge (2003) when they describe Environmental Perception and Behavioral Geography (EPBG), a Geography sub-discipline, as the study of the relationship between the self and the environment. They refer more specifically to environmental perception and its impact on actions, which is addressed in this research via the use of environmental values (see above), but also to the general belief that “all environments, essentially by their presence, constitute external sources of information for human beings” (*ibid*, p. 135).

Thus, this research is geographic in the sense that it is an analysis of human-environment interaction in the form of the pro-environmental behaviors recycling and composting. In addition, in order to address the more common perception of Geography as a study of place and/or space, spatial elements are considered as well. First, as noted in the Introduction, I performed a between-neighborhood descriptive analysis. Second, I make a comparison to results of this study and similar study undertaken in Exeter, England by Barr (2002). I could not locate any other piece of research that is analytically analogous to my research other than the study by Barr. Both of these elements strengthen the spatial component of the analysis, and thus render it more explicitly geographical in the common perception of the discipline.
Chapter 3 Description of Study Area

3.1 Geographic Setting

The study was undertaken in Denver, Colorado, United States (see figure 1), which had an approximate population of 554,636 as of 2007, according to the United States Census Bureau (U.S. Census Bureau 2007). Denver’s populace is a mix of various socio-economic and demographic backgrounds, and possesses members of all age groups, education classes, household types and sizes (The City and County of Denver, 2007). The variable nature and size of Denver’s population makes it an ideal setting to research effects of different demographic and social correlates of behavior. Regardless of how suitable the population is for a study such as this, it is recommended that motivations for recycling behaviors should be undertaken on a place-by-place basis (Vining and Ebreo 1990, Blaine et al. 2005), thus if one is interested in waste management analysis in Denver, it is best if data from Denver are used. Further, as pointed out by Amadeo and Golledge, at the core of Geography is the notion that “activities and experiences must be understood in terms of the environmental contexts in which they occur” (2003, p. 135). This notion is corroborated by Hargreaves (2011), who stresses the context-dependant nature of pro-environmental behavior research. The spatial context for this study is the areas of the City and County of Denver that were selected for study.
Figure 3.1 Denver, CO, U.S.A.

3.2 Waste Management Services in Denver, CO

“Denver Recycles” (DR) is a sub-department of the Denver Solid Waste Authority, and oversees recycling services in the city. Recycling services are free to all Denver residents of single-family dwellings and multi-family dwellings that have seven units or less, while trash removal is free and available to all residents. Residents that live in buildings with more than seven units have access to public recycling facilities, as there are many community recycling bins located throughout the city. Fee-based recycling services are also available through a number of private companies. Signing up for free recycling service can be accomplished by registering at the DR website (City of Denver, 2011). Until June of 2005, DR accepted six materials in curbside recycling bins, and seven additional materials were added as of June 2005 (see Appendices B and C). The materials do not need to be separated – this method is called “single stream recycling.” In other words, all recyclable materials can be put together in one bin without being separated. This is obviously a much more convenient means of recycling than being

---

required to separate materials. At the time data were gathered for this study, DR had recently phased out the use of small individual recycling bins and replaced them with much larger wheeled carts in an effort to make recycling more convenient. The new carts were completely phased in by January of 2007 (Pitt 2007), though some residents at the time this research was undertaken were still using the smaller bins.

At the time this research was undertaken, the city did not offer curbside composting service, though household composting was supported by a number of indirect means. Denver Recycles made household composting information readily available on their website, and offered free composting classes throughout the year. This information and training was made available in an attempt to increase home composting. “Grass-cycling,” a form of home composting, was also encouraged by DR on their website. Grass-cycling is achieved by leaving grass clippings created by mowing in place on the lawn. Not only does this reduce the burden on landfills and prevent GHG emissions⁹, but it also increases nutrient and water retention on lawns, reduces lawn maintenance costs, and minimizes the amount of time spent on lawn maintenance (City of Denver, 2011b). Finally, leaf drop off sites were made available in the fall, and limited yard waste pickup was available to residents. The latter two services do not promote home composting \textit{per se}, but they are yard waste management services that ultimately result in reuse of organic materials through mulching.

As of the spring of 2011, the leaf drop off and limited yard waste pickup policies remain in place, composting and grasscycling information are still available on the DR

---

⁹ See details regarding anaerobic digestion in Chapter one for GHG implications of organic material in landfills.
website, and composting classes are still offered throughout the year\textsuperscript{10}. However, one aspect of composting policy has changed significantly, especially in regards to this research. Namely, the city now offers curbside composting services to limited areas of the city. A successful curbside composting pilot study resulted in fee-based composting service being available to city residents in select areas\textsuperscript{11}. This is a significant step toward responsible management of the organic component of MSW, and has implications for future research, as can be seen in the Discussion section.

3.3 Neighborhoods Surveyed

Given unlimited resources, I would have attempted to procure a representative sample of the entire City and County of Denver, and thus (assuming the proper level of participation) would be able to make statistical inferences that would consider the residents of Denver as the population. However, given the temporal\textsuperscript{12}, financial\textsuperscript{13} and human resource\textsuperscript{14} constraints in the data gathering, I reduced the survey area considerably. This lack of resources was an important consideration in choosing the survey area. The second condition that limited the survey area was also practical in nature: as will be seen in the following section, the study instrument chosen in this analysis was a 17-page survey that was physically handed to participants, then collected

\textsuperscript{10} There are currently 28 classes available throughout the year. See \url{http://www.denvergov.org/trashrecycling/TrashandRecycling/CompostingOrganics/CompostingClasses/tabid/438333/Default.aspx} for class schedule as of May 2011.


\textsuperscript{12} I had approximately 2 months to gather the data.

\textsuperscript{13} This research was self-funded, aside from a generous $300 research grant given by the Department of Geography at the University of Denver. This grant was sufficient to cover most of the printing costs.

\textsuperscript{14} Given the financial constraints, I administered and gathered all of the surveys, which as will be seen in the following section required a considerable time commitment. It is hoped that a large group of assistants will be available if future research of this nature is undertaken.
by hand. This type of data gathering limited the survey area precisely because I had to be physically present in the areas being studied. Simply put, there are some areas of the city that I was not comfortable walking around and knocking on doors unannounced. This limited the representativeness of the samples in at least one regard. Namely, that this resulted in surveying relatively affluent neighborhoods. This is not to say that more low-income neighborhoods were more dangerous, but that I was not familiar with them, and did not “feel” comfortable knocking on doors unannounced. This says as much about my personal psychology as much as it does the neighborhoods in question, if not more. Regardless, it reduced the representativeness of the sample.

Taking all of these factors into consideration, I chose to survey nine U.S. Census Tracts: Speer, Washington Park West, Capitol Hill, Cheesman Park, Congress Park, City Park, Corey-Merrill, City Park West, and Whittier (see Figure 3.2 and Figure 3.3). These census tracts were not chosen scientifically, *per se* – they were chosen because I felt that 1) they could be surveyed in the given time frame and with the given resources and 2) I felt safe walking alone in them and knocking on doors unannounced. This compromises the representativeness of the sample, but was pragmatic in nature.
Figure 3.2 Census Tracts of Denver, CO. Surveyed census tracts are highlighted in grey.

Figure 3.3 Census Tracts Surveyed for the Study
Chapter 4 Methods and Research Questions

4.1 Research Design

4.1.1 Behavioral Model

The inherent complexity of behavior allows researchers to choose any number of variables to study, as can be demonstrated by the studies detailed in the literature review. After performing the literature review, I found that Barr’s 2002 and Barr and Gilg’s 2005 study of waste management behavior analyzed the most comprehensive list of variables, and thus provided the most robust behavioral model.

I chose to largely base this study on their waste management model (see Figure 2.3), with two important exceptions: First, though intent to engage in a behavior is widely viewed as the most direct antecedent of behavior itself (Barr, 2002), I chose not to quantify intent to recycle and compost in this study. This was partly a pragmatic decision, in that adding intention-based questions increased the length (two additional pages) of the already lengthy survey (17 pages), and that respondents to test surveys that contained intention items noted that the intention questions seemed redundant and unnecessarily increased the length of the survey. In addition, the literature is rife with studies that do not measure intent to engage in behavior, but measure behavior directly, thus it is apparent that viable research can be undertaken without measuring intent. Intent can be viewed as both an independent and dependent variable, as Barr (2002) and Barr and Gilg (2005) demonstrate. Behavior is the focus of this research, for it is waste
management behavior (not intent) that most directly result in the impacts discussed in Chapter 1, thus it is not an important dependent variable. Excluding intent does potentially compromise the explanatory capacity of this research, insofar as intent is a variable that leads to behavior, but the results are still useful in their absence as many other studies indicate. Given the limited resources I had to complete this research, a high response rate was imperative in order to obtain a statistically significant sample, thus I removed the intention items.

The second way the behavioral model in this study differs is that it includes habit strength as an independent variable. Inclusion of habit is important for a number of reasons. First of all, habits have been shown to be correlated with corresponding behaviors (e.g. Verplanken & Orbell 2003), including recycling (Knussen and Yule 2008, Klöckner and Oppedal 2011), so the inclusion of habit adds to the explanatory capacity of the model. In short, measuring habit formation strengthens the model. Secondly, habit quantification can have important implications for waste management policy in Denver. If habit strength is shown to have a strong correlation with recycling and/or composting behavior, the city can pursue ways to influence habit formation among city residents. Thus it may provide another way to increase responsible waste management behavior in the city. Finally, the addition of habit to Barr and Barr and Gilg’s model adds an additional element of separation between their research and the research undertaken for this study. As explained previously, it has been noted that implications of PEB research are mostly relevant to the geographic area in which the research was performed (Vining and Ebreo 1990), so this research is unique. However, the addition of habit strength to
the mix of variables further separates this research from others done in the past. In fact, of the published research to date, only Klöckner and Oppedal (2011) have analyzed the impact of both SRHI-measured habit strength and a mixture of situational and psychological variables on waste management behavior or other PEB, though this study distinguishes itself from Klöckner and Oppedal in a number of ways\textsuperscript{15}. Since the time the data were gathered for this research, de Bruijn (2010) has undertaken research that combines the use of the SHRI with other constructs used in this research, but de Bruijn studied exercising behavior. Thus, this study is unique in that it is the first to analyze influences of waste management behavior in Denver and is the first to analyze the impact of the set of variables I have chosen for this research.

\textbf{Figure 4.1 Behavioral Model of Waste Management in Denver, CO.}

\textsuperscript{15}Important differences between this study and Klöckner and Oppedal’s are: they did not analyze demographic characteristics, they did not perform factor analysis to verify their variable groupings (see Methods section below), and their sample was derived solely from undergraduate students in Norway.
Figure 4.1 shows the behavioral model that I have derived for this study. Note the similarities between this model and Barr’s and Barr and Gilg’s (Figure 2.3), but with the addition of a habit variable. This model proposes, broadly speaking, four categories of variables in the analysis of waste management behavior. First, environmental values, which will be measured by responses to the modified NEP scale proposed by Barr (2002) and Barr and Gilg (2005) (see below for description of this scale). Second, psychological motivators and barriers are included, including attitude, subjective norms, self-efficacy, perceived convenience, and response-efficacy. The third category of variables is “situational,” which includes socio-demographics, actual convenience, and concrete knowledge. Finally, habits were included and measured by responses to the SRHI questionnaire. Note that the dotted lines connecting habit to the situational and psychological variables indicate that habits fit into both of these categories. Habits, simply put, are automated responses (hence, psychological) to external stimuli (hence, situational).

It is important to note that the individual sub-categories (e.g. attitude, self-efficacy, actual convenience) are proposed variables, and may not come to pass when the analysis is undertaken. As will be seen in the next section describing the questionnaire, specific questions are designed to ascertain the influence of each category and sub-category of variable. However, whether or not each of these (sub-)categories is incorporated into the final regression-based model depends on the results of factor analysis. These results cannot be dictated a priori – the factor analysis separates (“loads”) individual variables into groups/categories based on statistical similarity, which do not always coincide with
preconceived categories. Thus, questions are grouped into categories and sub-categories that may or may not align with those I intended. These groups can be seen in the Results section.

4.2 Methods

4.2.1 Data Collection Method

As noted in the previous chapter, the study area was chosen in part by the nature of the survey instrument and administration method. For this study, the data were survey-based and gathered via a “call and collect” method, which is modeled after the technique used by Barr (2002). The first step in data collection was to select the households to be sampled. I chose to utilize a hand-administered hard copy survey, for the reasons described in the next section, and used stratified random sampling to determine the sample. A stratified random sample “divides the population into separate groups, called strata, and then selects a simple random sample from each stratum” (Agresti & Finlay 1997, p. 26). In this study, the nine census tracts were the strata, and 40 samples (residences) were randomly chosen from each census tract. Stratified random sampling was used instead of simple random\(^\text{16}\) because I wanted to garner sufficient responses from each neighborhood to perform parametric tests on each neighborhood’s responses in addition to performing them on the sample as a whole. A sample size (“N”) of approximately 30 is generally accepted as the minimum sample size to assume a normal distribution. If a 75% response rate could be achieved, this benchmark could be reached if 40 surveys were administered to each neighborhood. Also, after consulting with an

\(^{16}\) A simple random sample would require random selections be made from all of the household in all the census tracts, not a given number from each census tract.
expert in statistical analysis, the other response goal was to have at least 200 usable surveys in order to be able to perform many of the analyses, which would only require a 55.5% response rate.

The data points were chosen through the use of ArcMap©, a software created and maintained by Environmental Systems Research Institute (ESRI 2007). ArcMap is a mapping and data/spatial analysis program, and was used to both generate the stratified random samples and to create maps that were used as navigational tools to administer the surveys. ArcMap enables the user to add map “layers” that contain spatial and/or tabular data. For this analysis, I first loaded layers containing shape and location information for all of the parcels, streets and census tracts in the City and County of Denver. This created a huge and cumbersome data set/map, so I “clipped” this aggregate data according to the borders of the census tracts that were designated for analysis. Clipping data eliminates all of the spatial data that are outside the boundaries of designated areas – in this case, all data that were not within the boundaries of the nine census tracts of interest were eliminated\(^\text{17}\) (Figure 4.2). Upon clipping I was left with 15,837 parcels, which was reduced from 165,424 parcels in Denver as a whole.

\(^\text{17}\) Note that if one desired to obtain a representative sample from the entire city of Denver, clipping would not be necessary.
The stratified random sample was obtained as follows: First, I created individual maps of each neighborhood. Each map contains discrete polygons for every municipal parcel of land that resides within the tract, and each polygon has tabular data associated with it that contains at minimum a unique (integer) identifier (the “FID” field) that differentiates it from all of the other polygons in the file. The parcels represented one of three things: residential housing, businesses or parks. I was able to eliminate the parks according to a “parks” layer. The parcels were chosen randomly through the use of the FID field. Using a random number generator\(^\text{18}\), I chose the given number of parcels (40 in each neighborhood) by generating 40 random numbers from the set of FID integers associated with the parcels in the map. For example, if there were 1200 parcels in the map (e.g. the Capitol Hill Neighborhood), I asked the generator to produce 40 integers (non-duplicative) from the set of numbers 1 through 1200. I then selected these parcels on the map, highlighted them, and printed the map out to use as a navigation guide. Figure 4.3 shows an example of twenty randomly selected parcels in the Capitol Hill

\(^{18}\) Available at \url{http://www.random.org/integers/}, a website maintained by Trinity College in Dublin.
neighborhood. Note that this was a test map, and the parcels were not selected to participate in the study – providing a map of locations surveyed would compromise the anonymity of the respondents. A map with 40 randomly selected parcels for each neighborhood was generated, and used as a guide to administer the surveys.

Figure 4.3 Twenty Randomly Selected Parcels in the Capitol Hill Neighborhood of Denver, CO.

After randomly choosing the household/parcel to be surveyed, I visited each selected household\textsuperscript{19}. Note that businesses were not eligible for the study, so if a business parcel was selected, I moved to the adjacent residential parcel, according to the

\textsuperscript{19} If the randomly selected parcel was an apartment building, I randomly selected an apartment to solicit, and contacted the residents through the “call” button, if one was available. If no call button was available, I waited until someone entered the apartment building, and asked them to participate. If either of these methods were not successful, I went to the adjacent parcel.
procedure explained below. If someone answered the door, I briefly explained the
purpose of the research and asked the resident if they would be willing to fill out the
questionnaire. As an enticement, I informed them that I would randomly select three
survey participants after all of the surveys were collected, who would each receive a $50
cash prize. In order to be considered a qualified survey participant, the resident had to fit
two criteria: First, they must be at least 18 years of age, as required by the University of
Denver Internal Review Board. It is clearly outlined on the survey instrument that the
person who fills out the survey must be at least 18 years of age. If the person who
answers the door appears to be under the age of 18, I asked if there is someone at least 18
years of age who could be spoken to, and they are asked to fill out the survey. The
second qualification is that the person surveyed must be a resident of the selected
household. This is important because I hoped to gather representative samples from each
neighborhood, thus I wanted to be sure the person surveyed resided in the given
neighborhood. I chose to respect all requests (via signage or otherwise) to not solicit, as
it was important that I was respectful of all individuals, whether or not they were
involved in the study.

If no one answered the door, refused to take the survey, or was not a qualified
person, I went to the adjacent house and attempted to administer the survey again, using
the same survey administration procedure. The adjacent house was chosen according to
the following procedure. I went to the closest dwelling in the northern direction\textsuperscript{20} on the

\textsuperscript{20} If the street was not oriented exactly north-south, I went in the northernmost direction that would allow
me to stay on the same side of the street. For example, if the street was oriented NW-SE, I went to the
residence on the same side of the street, walking northwest; if it was NE-SW, I walked to the northeast,
staying on the same side of the street.
same side of the street, until I could no longer travel in a northern direction and remain in the same census tract. If I could no longer travel in a northern direction in the tract, I went to the next residential unit to the west, then as soon as I could move in a southern direction, I did so, staying on the same side of the street. I continued south until I could no longer do so and remain in the tract, at which point I would go west again, then north as soon as I could. The pattern was then repeated until a survey was successfully administered. I repeated this process until a qualified respondent agreed to participate in the survey. Figure 4.4 shows a hypothetical pattern that would be undertaken in order to administer a single survey. The purple-colored shapes are parcels in the desired census tract, and the white lines between the parcels are streets. The circled polygon indicates the randomly selected parcel, and the numbered arrows show the paths that would be taken (in order) to administer the survey.
If the resident agreed to participate, I informed them that I could return later the same day to pick up the completed survey, but would otherwise return the following day to pick it up, and that they had the option of returning the survey in person or leaving it in a safe and accessible location on the premises. As will be seen in the results section, many respondents returned the survey the same day it was administered. Upon return to the household, if the survey was not visible, I personally asked if the completed survey was available. If the resident answered the door, but had not completed the survey, I informed them that I would return the following day. If the survey was not left in a visible location and no one answered the door, I left a note explaining that I would return the following day. On the third visit to the household, if the survey was not available and no one answered the door, I left another note explaining that I would return the next day.
If the survey was not collected on the fourth visit, I left a final note explaining that they could contact me to return the survey if they still wished to participate in the research. If I was able to speak with them in person, I explained that they were still eligible to participate, but that they would need to contact me in order to do so. I did not return after the fourth day unless explicitly invited to do so.

4.2.2 The Survey Instrument

I chose to provide the survey in person via hard copy as a result of multiple considerations. The first consideration was borne of cost combined with the desire to retrieve a large enough sample to perform a robust and statistically significant analysis. The goal of the survey procedure was to garner enough valid responses to assume a normally distributed sample size in each neighborhood, which would require a minimum of 30 responses from each neighborhood. Given the cost and time restrictions, it was infeasible to administer the surveys by mail. Mail-in surveys require at least two postages – one to send the letter and one for the return. Ebreo et al. (1999) note that a nearly 54% response rate is “within the range that is normally acceptable for mail surveys (117). If my study achieved a 50% response rate, the minimum cost for postage alone would be $44.40 per neighborhood\(^21\), and this does not include the cost of the printing, envelopes or reminder mailings. Such a budget would easily have surpassed $500-$1000\(^22\), which was beyond the means available at the time. Even a 100% response rate – an extremely unlikely outcome - would cost a minimum of $300 to $400 given the desired sample size. Secondly, a hard copy delivered by hand should result in a relatively

\(^21\) At the time the study was conducted, a first class stamp cost $0.37. Each survey would thus cost $0.74, and to receive a minimum of 30 surveys, 60 would need to be sent out, for a total cost of $44.40.

\(^22\) Printing costs for the project were approximately $350.
high response rate. Barr and Gilg (2005) attributed their high response rate (69%) to the personal interaction that resulted from hand-administration of the surveys. Unlisted phone numbers and the preponderance of cell phone use eliminate a large pool of potential subjects if phone surveys are used. Also, phone numbers as identifiers are difficult to apportion according to neighborhood, as they are not spatially-based. Thus I did not use a phone survey, though it would have been quite inexpensive. I considered using an internet-based survey, but could not solicit entries according to neighborhood with this method either.

The survey instrument consisted of 17 pages (see Appendix D). It included a cover page explaining the purpose of the survey23, who it was administered by, notification of the availability of the cash prize, and my contact information. Directions for filling out the survey were also supplied. The bulk of the document (twelve pages) contained the questionnaire, which consisted of 78 numbered questions, with 25 subquestions24 that were designed to a) address items in the conceptual framework and b) ascertain information that may help DR improve or otherwise modify waste management services. Note that I created eight versions of the survey, which varied in three ways: 1) Half of the surveys asked if they would be willing to pay $3/month for a) composting services and b) garbage and recycling pickup, and the other half asked if they would be willing to pay $1/month; 2) half of the surveys listed composting-based questions first, half asked recycling-based questions first; and 3) half of the surveys had behavioral frequency as the

---

23 As recommended by Barr (2002) following recommendations by Dillman (1978), no mention was made of the purpose of the research being for a Master’s thesis,

24 Recycling and composting behavior was considered one question, though there are 17 sub-questions that address the frequency with which individual items are recycled or composted. Similarly, the NEP scale was considered one question, though it contains 8 items.
first question, and half had it as the third question, after asking if recycling and
composting were important. This was done in an attempt to limit the ordering bias of the
questions. The question description and goals are as follows.\footnote{The descriptions are of a survey that had a) composting questions before recycling questions and b) behavioral items first.}

Section one (questions 1-67) contained questions pertaining to recycling and
composting, and section two (questions 68-78) had demographic-related questions. Note
that answers to Likert-scale questions were recoded when necessary so that when I
performed the data analyses, a higher score meant more frequent behavioral occurrence
and a stronger positive view of the value in question. Question one contained 17 sub-
questions that asked the frequency with which the respondent recycled or composted
specific items. Five Likert-style options were given, in a scale that ranged from “never”
to “always.” Note that items were included that DR allows (see Appendices C and D)
and disallows (e.g. plastic tubs and plastic bags) for recycling. Non-recyclable items
were included to ascertain to what extent residents are putting items in the recycling bin
that should not be there. This could have implications for DR’s publicity efforts.\footnote{For example, if residents report high rates of plastic bag recycling, DR should consider undertaking a publicity campaign reminding people that plastic bags are not to be placed in the recycling bins.} A
sub-question regarding grass-cycling was included as well.
Questions 2 and 3 address the “attitude” construct in the framework model (acceptance of the importance of recycling/composting). Questions 4 – 11 were designed to glean information that could potentially be useful to DR, including willingness to pay (WTP) for services and what positive impacts of recycling/composting would motivate them to recycle (global climate change, job creation, as well as personal and county-based economic benefits). Questions 2-11 utilized 5-item Likert scales, ranging from “unimportant” to “very important.” Questions 12, 14 and 15 addressed concrete knowledge (what can be recycled, how often it is picked up, and need to separate recyclables). Questions 13 and 16-21 were designed to provide information to DR, including where residents get information about recycling/composting (website, TV, radio ads, etc.) and what prevents them from recycling/composting/grasscycling. Questions 22 and 23 asked if the respondent has a garden, and if so, whether or not they use their compost in the garden. Having or not having a garden will be used for a descriptive statistic (do gardeners compost more than non-gardeners?), and may also be a situational variable. Question 24 has 8 sub-questions with the NEP scale items (see Figure 4.5). This is a modified scale that was utilized by Barr (2002) and used a 5-item Likert scale ranging from “strongly disagree” to “strongly agree.” The test survey used the 12-item NEP scale derived by Dunlap et al (2000), but feedback from test.
respondents indicated that some of the questions on the scale were “odd” and somewhat confusing. The modified 8-question NEP scale used by Barr (2002) was found to be more acceptable to test respondents, thus it was used. There are a number of NEP scales available that have been used in various studies with varying degrees of success, and Cordano et al. (2003) recommend that the choice of NEP scale should be made on a study-by-study basis.

Questions 25, 26, 29, 30, 35 and 36 address the subjective norm of composting/recycling (awareness of norm and acceptance of the norm), while questions 27, 28, 33 and 34 address perceived convenience and/or personal efficacy (recycling/composting is easy and/or too time consuming to worry about). Questions 31 and 32 were meant to address response-efficacy (recycling/composting is not justified due to small amount created), and questions 37 and 38 addressed self-efficacy (recycling/composting on a daily basis is possible). Question 39 is meant to provide DR with information regarding whether or not residents are aware that DR will provide them with a bin for free. Questions 40 – 63 contain the 12 question SRHI for recycling and composting (12 for each behavior). Questions 64 – 66 were to be answered by respondents that use the large, wheeled cart, and were meant to ascertain 1) if they recycled more or less than they did when they had the smaller bins and 2) why they recycled more or less. This information can be potentially be used by DR, as it delineates explicitly why the bigger bins are effective or not. Question 67 was only to be answered by respondents who lived in apartment complexes larger than seven units, and ascertained whether or not they recycled, and if so, where they recycled. This
information could also be useful to DR. Note that questions 25 – 63 had 5-item Likert-scale answers ranging from “strongly disagree” to “strongly agree.”

The final section consisted of questions 68 – 78, which were designed to gather demographic information. These questions addressed age, gender, education level, income, whether the home is rented or owned, type of residence, political affiliation, who is responsible for recycling, race/ethnicity, and language spoken at home. These data are “situational variables,” and will be integrated into the final behavioral model. One final note – Spanish and English versions of the survey were available, in case Spanish was the primary language spoken at home. The Spanish version was administered once, but the survey was not returned.

4.3 Research Questions and Data Analysis

4.3.1 A Note on Statistical Methods and Research Goals

After all of the questionnaires were collected, the data from the surveys had to be compiled before the analysis was to take place. The dataset that resulted from aggregation of the answers to the questionnaire is large – 199 completed surveys and 101 questions per survey - and would be very difficult to interpret without aggregating the data. For this report, statistics were used to summarize data most relevant to the research. A dataset with so many variables can be used for a multitude of low- and higher-level statistical analyses. As described in the Introduction, the overarching goal of this research is to inform waste management policy in Denver as it relates to recycling and composting. The data analysis focused on variables that are most pertinent to this goal, which are correlates of waste management behavior as well as data that are directly
related that behavior. Data that are not pertinent to the research goal were not analyzed in this report. In short, there are many other analyses that could possibly be performed using the data gathered for this study in addition to the analyses contained within this report. Given the focus of this piece of research, these other analyses may be performed at a future date and/or provided to the City and County of Denver in an effort to assist them in waste management policy. Not all of the data will be used in this analysis, but may be used in future research undertakings.

4.3.2 Descriptive Statistics

The first portion of this analysis utilizes descriptive statistics, which, simply put, are ways to “summarize and describe data, to make the information easier to assimilate” (Agresti & Finlay, 1997, p. 35). Descriptive statistics describe the sample only, and do not make any claim to describe the population as a whole. In this study, descriptive statistics describe characteristics of the respondents, and claim no implications for the population of the neighborhoods, or Denver as a whole. Perhaps the most common descriptive statistics are the calculation of means, medians, modes and standard deviations. I used descriptive statistics to provide the reader with 1) a general idea of waste management behavior among the survey respondents (e.g. frequency with which each material is recycled), 2) a description of the survey respondents (demographic descriptions) and 3) summaries of responses to the NEP and SRHI constructs.

---

27 In statistics lingo, “population” refers to the “total set of subjects of interest in the study” (Agresti & Finlay, 1997, p.4). In this study, the residents of the nine census tracts are the population. If the sample was drawn randomly from the City of Denver as a whole (i.e. each resident of Denver had an equal chance at being chosen), then the population would have been the residents of Denver. A “sample” refers to the subset of the population for which data were collected. In this study, they survey respondents are the sample.

50
of graphical and tabular descriptions of data is used to summarize the data. Graphs and tables are very efficient way to display large, aggregated data sets, and are commonly used in research of this nature.

4.3.3 Multivariate Inferential Statistics

Inferential statistics provide predictions (inferences) about the population being studied based on the sample statistics (Agresti & Finlay, 1997). Inferential statistics are powerful tools, as they enable the researcher to describe the population being studied while limiting the data that need to be gathered. In this study, the sample size of 199 (the number of completed surveys) will be used to describe the population (approximately 15,000 households in nine census tracts). However, the strength of this type of analysis – being able to describe the population with a subset (sample) – can also be a weakness because inferences must be made. It is often much easier to gather data for a sample than from a population, but inferential statistics have probabilistic limitations. The probability that a sample statistics is indicative of a population parameter is denoted by a “probability level.” A probability level is expressed as a decimal, usually in the form of “p < n.” The variable “n” is a decimal that indicates the level of confidence that the null hypothesis can be rejected. For example, a confidence interval of p < 0.05 indicates that the researcher can be confident that the same result would occur 5% of the time or less if the null hypothesis were true. In other words, there is a 5% or less chance that the researcher incorrectly refuted the null hypothesis. A p < 0.01 indicates a 99% chance that the null hypothesis is correctly rejected. A 95% confidence interval is the most commonly
accepted level of confidence in statistical analyses, and is the benchmark confidence interval used in this study.

4.3.4 Creating the Behavioral Model

Multivariate statistics, as the name implies, involve the analysis of more than two variables. The two multivariate statistical analyses employed in this research are factor analysis and multiple regression analysis. Factor analysis is very beneficial for an analysis such as this one, in that it reduces the burden and potential confusion of assessing the impact and/or explanatory power of many variables on an individual basis by creating groups of variables with similar characteristics. Factor analysis assesses the intercorrelation of multiple variables and provides statistical evidence of this correlation (Agresti & Finlay 2003). This has multiple benefits. First of all, it can simplify an analysis by reducing the number of variables. Variables can be grouped into “factors” that are highly correlated, as dictated by the results of factor analysis, and these factors can thenceforth be treated as variables. For example, Whitmarsh and O’Neill (2010) analyzed 24 behavioral antecedents to engaging in PEB (purchasing carbon offsets) using a factor analysis and were able to reduce these 24 variables into 8 factors, and thus reduced the number of variables they needed to analyze by 66%. This is a common procedure in research that involves many variables, including ones that assess PEB (e.g. Nooney et al. 2003; Barr and Gilg 2005). Factor analysis is also explanatory in nature, in that it can organize variables into groups that are statistically similar, but may not adhere to preconceived grouping. In this way, factor analysis explains the relationship between variables.
For this research, factor analysis was used for both of the reasons listed above. First, it was used to group independent and dependent variables into factors, thus reducing the number of variables. This made modeling simpler and more intuitive. It was also used to explain the relationship between variables, which helped confirm or deny the variable groupings I proposed.

Regression analysis is a statistical method that determines the influence of one or more independent variables on a dependent variable. The result of a regression analysis is an equation that incorporates independent variables that are shown to have a significant impact on the dependent variable. When the values of independent variables for a data point are known, this equation predicts the value of the dependent variable within a given level of confidence (Agresti & Finlay 2003; McDonald 2009). Two types of regression were used in this study. “Stepwise regression” takes any number of variables and assesses their impact on the dependent variable by integrating them into the regression equation, and eliminates variables that do not have a significant impact on the dependent variable. This reduces unnecessary complexity of the regression equation and simplifies the explanation that needs to be offered by the analyst. “Standard least squares regression” was used after stepwise regression. Standard least squares regression enters the variables retained by the stepwise regression into the regression equation, resulting in an equation that describes a line that best fits the data points. The regression coefficients and their correlates were used to populate the behavioral model described previously. Figure 4.6 shows the directional model of statistical analysis that was used in this study.
All of these statistical procedures are explained in more depth in the Results section below.

![Statistical Analysis Model](image)

**Figure 4.6 Statistical Analysis Model for Waste Management in Denver**

### 4.3.5 Research Questions

The primary goal of this analysis is to inform waste management policy in the City and County of Denver. Two sets of analyses were undertaken with this goal in mind. First, I calculated descriptive statistics relating to questions designed to directly address contributors to and detractors from recycling and composting behavior (e.g. “What prevents you from recycling regularly?”) and second, I determined to what extent the independent variables indicated in the behavioral model illustrated in Figure 4.1 correlate with the self-reported composting and recycling behavior. As indicated in Figure 4.1 and explained in depth in the survey instrument description, the independent variables are socio-demographics, actual convenience, concrete knowledge,
environmental values, attitude, subjective norms, self-efficacy, perceived convenience, response efficacy and habit strength. Of special interest is the determination of the strength of the correlation between habit strength and PEB relative to the other variables in the model. Note that as explained in Section 4.1.1 Behavioral Model, these variables may not all be incorporated into the final model. The survey questions were designed to address the full suite of variables groupings, but the actual groupings were dictated by the results of the factor analysis.

Most of the other research questions are related to the primary goal. For example, I hoped to ascertain the characteristics of a “typical” recycler and composter in the surveyed neighborhoods. The demographic variables were used in this regard, including gender, education level, household type, rent/own, political persuasion and age. Another related research questions is to determine how strongly environmental values are correlated with self-reported PEB. The literature is ambivalent in terms of the relationship between NEP scores and PEB, and this study was intended to contribute to the body of research. Conversely, there is near universal agreement that actual and perceived convenience is strongly correlated with recycling behavior. I anticipated that this will also be the case for the sample in this report. I felt it would also be interesting to see if perceived convenience also has a significant impact on composting, or if other factors are stronger.

A research outcome that is not related to the behavioral model is finding out to what extent residents are willing to pay for recycling/garbage and/or composting services. Will people be significantly more willing to pay $1/month than $3/month for services?
Another unrelated research question is whether or not residents are putting non-recyclable materials (plastic tubs, packaging, and plastic bags) in recycling bins, and to determine which materials are being recycled at the highest rate. Also, descriptive statistics are used to provide DR with pertinent information about waste management services, including what prevents residents from recycling and/or composting, what motivates residents to recycling and/or compost, why people do/do not grass-cycle, where residents get recycling information, if residents like the large bins and why (not), and how frequently apartment dwellers recycle, and if so, what service they use. Finally, a descriptive analysis of neighborhood waste management behaviors and other variables is undertaken, as is a comparison of results between Barr’s 2002 Exeter study and this study. Both of these are done in an effort to analyze spatially distinct places and possibly propose geographical differences between locations.

4.3.6 Survey Administration and Data Analysis

The neighborhoods were surveyed during the summer of 2007. The first survey was administered on June 6th, 2007 and the last survey was collected on July 27th, 2007. In order to maximize the likelihood that residents would be at home, I administered during non-working hours only – I began after 5:30 pm on weekdays and stopped at or before nightfall, and surveyed throughout the day on weekends. I personally administered and collected all of the surveys. As noted above, the survey respondents were visited a maximum of four times in order to collect a survey that was to be filled out. Respondents were not required to fill out the entire survey in order to be eligible for
the prize drawing, but did have to participate to some degree to be eligible. Response rates can be seen in the next section.

After all surveys were collected, I personally compiled and coded the survey results. The data were first entered into a Microsoft Excel© spreadsheet. All surveys responses were entered into the worksheet, but if a respondent did not provide answers to all of the questions that were to be used in the inferential statistical analyses, the survey was not included in the final analysis. Excel was used for the initial coding because it is a powerful data calculation tool and graphs and tables can readily be made for descriptive statistical analysis and display. Excel is also useful because it is compatible with the statistical analysis software chosen for this study, JMP© (SAS Inc., 2008). JMP© is a powerful software that can perform numerous statistical analyses with tabular data. All of the non-descriptive analyses were performed with this program.

---

28 Failure to answer questions that were meant to garner information for descriptive analysis only did not disqualify a survey from the inferential statistical analyses. For example, question 17 asks “Have you ever consulted Denver’s recycling website for waste management information?” This question is intended to inform DR to what extent respondents are consulting the website, and will not be used for anything but a descriptive analysis. If this question was not answered, it did not compromise the primary analysis of this report, the behavioral model, and thus a non-answer to question 17 did not disqualify a survey from analysis.
5.1 Survey Responses

Table 5.1 shows the response rates for the all administered surveys. The overall response rate of 75% is considered high in survey-based research, and in light of the considerable length of the survey (17 pages and 101 questions), this is a very impressive result. Less impressive is the response rate of usable surveys, which was only 56.5%. Unfortunately, I did not achieve my goal of 30 usable surveys from each neighborhood, and histograms of results (e.g. recycling and composting behavior by neighborhood) are not normally distributed, so only non-parametric tests could be used for analyses that compare neighborhoods. The Kruskall-Wallis test, which uses rank scores for nominal variables with more than two groups, could possibly be used, but this test is not descriptive enough to be useful in this analysis (McDonald, 2009). However, having 199 fully-completed surveys comes very close to achieving the goal of 200 surveys outlined in the Methods section. Most of the desired statistical analyses could thus be performed.
Table 5.1 Response Rates, Total and by Neighborhood

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Surveyed</th>
<th>Returned</th>
<th>Completed</th>
<th>Response Rate</th>
<th>Usable Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congress Park</td>
<td>40</td>
<td>27</td>
<td>20</td>
<td>67.5%</td>
<td>50.0%</td>
</tr>
<tr>
<td>Capitol Hill</td>
<td>40</td>
<td>21</td>
<td>19</td>
<td>52.5%</td>
<td>47.5%</td>
</tr>
<tr>
<td>Cheesman</td>
<td>40</td>
<td>39</td>
<td>32</td>
<td>97.5%</td>
<td>80.0%</td>
</tr>
<tr>
<td>Corey-Merril</td>
<td>32(^{29})</td>
<td>25</td>
<td>18</td>
<td>78.1%</td>
<td>56.3%</td>
</tr>
<tr>
<td>City Park West</td>
<td>40</td>
<td>29</td>
<td>18</td>
<td>72.5%</td>
<td>45.0%</td>
</tr>
<tr>
<td>City Park</td>
<td>40</td>
<td>33</td>
<td>23</td>
<td>82.5%</td>
<td>57.5%</td>
</tr>
<tr>
<td>Speer</td>
<td>40</td>
<td>26</td>
<td>23</td>
<td>65.0%</td>
<td>57.5%</td>
</tr>
<tr>
<td>Whittier</td>
<td>40</td>
<td>29</td>
<td>19</td>
<td>72.5%</td>
<td>47.5%</td>
</tr>
<tr>
<td>Washington Park West</td>
<td>40</td>
<td>35</td>
<td>27</td>
<td>87.5%</td>
<td>67.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>352</strong></td>
<td><strong>264</strong></td>
<td><strong>199</strong></td>
<td><strong>75.0%</strong></td>
<td><strong>56.5%</strong></td>
</tr>
</tbody>
</table>

5.2 Descriptive Statistics

5.2.1 Demographics of the Sample

Table 5.2 provides a summary of the demographic characteristics of individuals whose survey answers were used for inferential statistics. Note that filling out all of the demographic questions was not a prerequisite for being considered a “usable” survey. Only those questions that contained answers that were used in inferential statistical analyses were necessary to fill out. It is also important to point out that though the sample size was 199, some of the descriptive statistical questions allowed for more than one answer, thus more than 199 answers are possible for some questions.

The sample was approximately half female (55.8%) and almost entirely (80%) white, and was relatively evenly distributed among the age groups, though skewed slightly young, with over 60% being under 40 years old. A very high proportion have earned at least a bachelor’s degree, with nearly 30% having a graduate degree. The

\(^{29}\) Only 32 surveys were administered to the Cory-Merril neighborhood due to time constraints.
income groups were almost exactly evenly divided, with no group comprising less than 11% or more than 14% of the total sample. Small family sizes abounded, with only 20% having three or more people in the household. There were slightly more renters than homeowners, and the majority lived in single family detached homes (55.3%) and nearly all of the rest living in either apartments (21%) or duplexes (16%). The sample was overwhelmingly Democrat (58%) and had more Independents (34) than the rest of the political persuasions combined (33, not counting those who do not know).

Table 5.2 Demographic Characteristics of the Sample

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male (88)</th>
<th>Female (111)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race/Ethnicity</td>
<td>White (159)</td>
<td>Black/Af. American (13)</td>
</tr>
<tr>
<td>Age Group</td>
<td>18-29 (66)</td>
<td>30-39 (54)</td>
</tr>
<tr>
<td>Educational Level</td>
<td>No High School Diploma or Equivalent (3)</td>
<td>High School Diploma or Equivalent (7)</td>
</tr>
<tr>
<td>Income</td>
<td>&lt;$20,000 (22)</td>
<td>$20,000-$35,000 (27)</td>
</tr>
<tr>
<td>Household Size</td>
<td>1 (43)</td>
<td>2 (90)</td>
</tr>
<tr>
<td>Rent or Own</td>
<td>Rent (87)</td>
<td>Own (112)</td>
</tr>
<tr>
<td>Type of Residence</td>
<td>Single Family Detached (110)</td>
<td>Apartment (42)</td>
</tr>
<tr>
<td>Political Persuasion</td>
<td>Democrat (116)</td>
<td>Republican (20)</td>
</tr>
<tr>
<td>Primary Language Spoken at Home</td>
<td>English (196)</td>
<td>English &amp; Spanish (2)</td>
</tr>
</tbody>
</table>
5.2.2 Waste Management Behavior

As noted above, descriptive statistics summarize all of the data gathered from the sample, but do not make any inferences about the population. The following statistics are provided to give the reader a feel for who filled out the surveys (demographics), what they are recycling, to what extent they adhere to the NEP, and how strong their recycling and composting habits are. The mean score for the self-reported behavioral question items is indicative of the relative frequency with which each behavior is undertaken. All of the behavioral items were coded such that a higher score indicates a higher frequency. Each respondent was asked how often each of these items was recycled or composted, or how often grass-cycling was done (see Appendix D). These items utilized a 5-item Likert scale, and given the choices of “never” (coded as 1 point), “rarely” (2 points), “sometimes” (3 points), “usually” (4 points) and “always” (5 points). The results can be seen in Figure 5.1 and Table 5.3.

![Figure 5.1 Waste Management Self-Reported Behavioral Frequency in Survey Sample](image)

N = 199 for all materials except grass-cycling, which has an N of 168

*Grass-cycling has an N of 168 because 31 respondents indicated that they do not have a lawn. This does not affect average score or percent each answer was given.
Table 5.3 Mean Score on Self-Reported Behavioral Frequency Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Available Prior to June 2005</strong></td>
<td></td>
</tr>
<tr>
<td>glass bottles</td>
<td>3.69</td>
</tr>
<tr>
<td>newspaper</td>
<td>3.72</td>
</tr>
<tr>
<td>plastic bottles</td>
<td>3.69</td>
</tr>
<tr>
<td>aluminum cans</td>
<td>3.86</td>
</tr>
<tr>
<td>steel cans</td>
<td>3.44</td>
</tr>
<tr>
<td>aerosol cans</td>
<td>2.19</td>
</tr>
<tr>
<td><strong>Available During/After June 2005</strong></td>
<td></td>
</tr>
<tr>
<td>corrugated cardboard</td>
<td>3.30</td>
</tr>
<tr>
<td>paper board</td>
<td>3.31</td>
</tr>
<tr>
<td>mixed office paper</td>
<td>3.16</td>
</tr>
<tr>
<td>magazines and catalogs</td>
<td>3.31</td>
</tr>
<tr>
<td>phone books</td>
<td>3.62</td>
</tr>
<tr>
<td><strong>Not Recyclable</strong></td>
<td></td>
</tr>
<tr>
<td>plastic bags at home</td>
<td>3.01</td>
</tr>
<tr>
<td>plastic packaging</td>
<td>1.85</td>
</tr>
<tr>
<td>plastic tubs</td>
<td>2.22</td>
</tr>
<tr>
<td><strong>Organic Material</strong></td>
<td></td>
</tr>
<tr>
<td>kitchen waste</td>
<td>1.67</td>
</tr>
<tr>
<td>yard waste</td>
<td>1.82</td>
</tr>
<tr>
<td>grass-cycling</td>
<td>3.12</td>
</tr>
</tbody>
</table>

These results indicate that recycling can be considered normal behavior for the sample. As can be seen in Figure 5.1 and Table 5.3, all of the recyclable items except for aerosol cans were recycled, on average, between “sometimes” and “usually.” This indicates that the average respondent reported recycling these items more often than not. Aluminum cans were recycled at the highest rate, followed closely by glass bottles, plastic bottles, newspaper, phone books. Trailing slightly behind in average rate are steel
cans, corrugated cardboard, paperboard, mixed office paper, and magazines and catalogs. The non-recyclable items were generally put in the recycling bin at a lower rate, though plastic bags had nearly as high a recycling score as the recyclable items. This is perhaps a cause for concern, and will be addressed in the Results and Discussion sections. Two other phenomena are worth mentioning. First, it appears that aerosol cans are recycled at a lower rate than the rest of the items. This may have a policy implication, and will be addressed at the end of the report. Second, composting is clearly undertaken at a lower rate than recycling items, as reported by the sample. In fact, composting is undertaken at a lower rate than any of the non-recyclable items are recycled. This is not a surprising result, as recycling is a much more prominent issue than composting in Denver, as evidenced by the fact that home-composting services are available on a limited basis, yet recycling is widely available (and free). Finally, grass-cycling had a middling score, but it appears that people that do have lawns are likely to grass-cycle, as the sample consisted of only 110 detached single family homes, and in fact consisted of 42 apartments. Since apartment dwellers are very unlikely to be responsible for lawns, the average grass-cycling score underestimates the true rate, that is the rate that those with lawns grass-cycle.

5.2.3 NEP and SRHI Responses

The answers to the NEP question items were also on a five-item Likert scale, but the answers indicated the level of agreement with the statements listed in Figure 5.2, ranging from “strongly disagree” to “strongly agree,” with a higher score indicating a higher level of agreement with the statement. Higher adherence to a pro-environmental
viewpoint (the NEP, as originally defined by Dunlap and Van Liere, 1978) was viewed as a higher score. Some of the items had to be reverse coded in order to maintain the integrity of this scoring system. The reverse-coded items are indicated in Figure 5.2. On average, the respondents scored relatively high on the scale, though there are apparent differences in level of agreement between specific statements. These results are not unsurprising, as the items that scored lower could be considered more “extreme” than the ones that scored higher. The two lowest scoring items were “Human welfare should be our primary concern in the future” (mean = 2.81) and “Humans should not develop any more resources or land, in order to protect the natural environment” (mean = 3.02). These are very strong statements, and are very ecocentric. The more moderate beliefs, such as “If we over-use our natural resources, human development may be harmed in the future,” “Nature isn’t harmed by human changes” (reverse coded) and “The environment is of little concern to me” (reverse coded) can be viewed as rather reasonable beliefs, and are not extreme. As will be seen in the Results section, these questions load onto intuitive factors that closely mimic the scoring pattern in Figure 5.2.
Finally, the SRHI scores for recycling and composting can be seen in Figure 5.3 and Figure 5.5. Like the NEP items, the SRHI items are scored on a 5-point Likert scale ranging from “strongly disagree” to “strongly agree,” with a higher magnitude indicating a higher level of agreement with the statements in the scale. It is quite clear upon inspection of these results that composting habit strength is much weaker among the sample than recycling habit strength. This lends weight to the results in Table 5.3, and indicates strongly that composting is not “normal” behavior for the respondents of this survey. Overall, recycling habits appear to be strong, with all 12 items scoring above average (“agree”). All of the composting items, with the exception of “I have no need to
think about (composting)” and “(composting is) typically me,” scored an average of below 2 points. It is odd that these two items scored higher. The highest score being the “no need to think about” item makes sense, in that respondents may misconstrue the intended meaning of this answer to be that they don’t have to think about it because they rarely engage in the activity. I cannot conceive of an explanation why item 11 scored higher, however.

Figure 5.3 Self-Reported Habit Index Scores for Recycling

Composting/Recycling is something…
Item 1: I do frequently
Item 2: I do automatically
Item 3: I do without having to consciously remember
Item 4: that makes me feel weird if I do not do it
Item 5: I do without thinking
Item 6: that would require effort not to do
Item 7: that belongs to my daily routine
Item 8: I start doing before I realize I’m doing it
Item 9: I would find hard not to do
Item 10: I have no need to think about doing
Item 11: that’s typically “me”
Item 12: I have been doing for a long time

Figure 5.4 Self-Reported Habit Index Questions
5.2.4 Responses to Questions Directly Addressing Waste Management Policy in Denver

The figures and charts contained in this section summarize the answers to questions that were asked to have direct waste management policy implications for the City and County of Denver. The purpose of including these questions in the survey was to provide DR with useful information in regards to their policies.

Figure 5.5 Self-Reported Habit Index Scores for Composting

Figure 5.6 Desire for Free Compost Service in Denver
Figure 5.7 Willingness to Pay for Composting Service

How willing would you be to pay $1/$3 per month for pick-up composting service via a large, alleyway bin?

Figure 5.8 Willingness to Pay for Recycling and Trash Services

How willing would you be to pay $1/$3 per month (total) for garbage removal and recycling services?

Figure 5.6 through Figure 5.8 summarize the “willingness to pay” (WTP) for recycling and composting services in Denver. There was very strong support for free composting services, despite the fact that the sample reported rarely composting and had
very weak composting habits. Not surprisingly, as proposed composting cost rose, desire to participate dropped, though an interesting (and perhaps counterintuitive result) is that 65 people were extremely likely to use free service, but 68 people combined were willing to pay at least $1 for service. However, WTP was relatively strong overall, though even the highest monthly charge in this study ($3) is less than one third the cost of the optional recycling service being offered by DR currently ($29/quarter) (City of Denver 2011a).

Table 5.4 Summary Answers to “What, if anything, prevents you from composting regularly?”

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>Do not want to store kitchen wastes at home</td>
</tr>
<tr>
<td>64</td>
<td>I do not know how to compost</td>
</tr>
<tr>
<td>37</td>
<td>I never thought about it</td>
</tr>
<tr>
<td>21</td>
<td>I have no use for it</td>
</tr>
<tr>
<td>21</td>
<td>Nothing - I compost regularly</td>
</tr>
<tr>
<td>8</td>
<td>My contribution to the landfill is so small that it's unimportant</td>
</tr>
<tr>
<td>5</td>
<td>I thought about it, but it's not important</td>
</tr>
<tr>
<td>21</td>
<td>Other</td>
</tr>
<tr>
<td>3</td>
<td>No Answer</td>
</tr>
</tbody>
</table>

Figure 5.9 through Figure 5.12 summarize the support that composting and recycling receive relative to three important contemporary issues: climate change, job creation, the municipal budget and personal fiduciary concerns. It is somewhat surprising that climate change appears to be more important than the other three issues, as 125 respondents believed that recycling and composting would be “very important” if it had an impact on global warming/climate change, yet less than 100 indicated that the other three issues were “very important.” However, it is very important to point out that when this survey was taken, the global financial crisis had not yet occurred, and in fact the City and County of Denver was still in the midst of the housing bubble that (as it turned out)
artificially inflated the financial self-confidence of the general population, and Denver in particular. Combined with the fact that the respondents were moderately well-off and had a high level of environmental concern, it can be argued that this result makes sense. It is also possible that a bias occurred in this regard, in that the study is obviously related to PEB, and thus the respondents may (subconsciously or otherwise) fell obliged to over-represent their environmental concern.

Figure 5.9 Support for Waste Management as it Applies to Climate Change

Figure 5.10 Support for Waste Management as it Applies to Job Creation
Figure 5.11 Support for Waste Management as it Applies to the County Budget

Figure 5.12 Support for Waste Management as it Applies to Personal Finance

Figure 5.13 and Figure 5.14 reveal two important things about the sample. First, over half of the respondents who had a large recycling bin and answered the question in Figure 5.13 noted that they recycled “much more” with the new, larger bin than they did with the old, smaller bin. This lends support to the use of larger bins. Second, Figure 5.14 shows that respondents reported with overwhelming frequency that the convenience
of the larger bins is why they increase the recycling rate. This is further supported by the answers described in Table 5.5, which indicate that 65% of respondents who indicated that they are prevented from recycling in some way cite lack of convenience as a reason why, as indicated by the number that answered that either “recycling is not available,” there is a “lack of space to store recyclables” or “it is inconvenient.” These reasons are all indicative of a lack of convenience. Note that the second-most cited reason for the larger bins being conducive to recycling is the fact that a recycling information packet is included with the bin. This lends support to concrete knowledge being an important factor leading to PEB.

![Figure 5.13 Recycling Frequency as a Result of Large Bins](image-url)
Figure 5.14 Reasons for Increased Recycling with Large Bins

If you recycle more with the larger bin, why?

- Convenience of larger bins
- The bin is easier to see
- Information about recyclables came with bin
- Other

Figure 5.15 Recycling Methods used by Residents who are not Eligible for Home Recycling

If you live in an apartment with more than seven units and you recycle regularly, what service do you use?

- Private Company
- Community bin on street/alley
- Community bins at grocery stores

Table 5.5 Aggregated Answers to the Survey Question "What, if anything, prevents you from recycling regularly?"

<table>
<thead>
<tr>
<th>Number</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>126</td>
<td>Nothing - I do it regularly</td>
</tr>
<tr>
<td>28</td>
<td>It is not available at my residence</td>
</tr>
<tr>
<td>24</td>
<td>Lack of space to store recyclables</td>
</tr>
<tr>
<td>16</td>
<td>I've never thought about it</td>
</tr>
<tr>
<td>12</td>
<td>It is inconvenient</td>
</tr>
<tr>
<td>7</td>
<td>It's too far to travel to the bin</td>
</tr>
<tr>
<td>6</td>
<td>Do not want to separate materials</td>
</tr>
<tr>
<td>4</td>
<td>My contribution to the landfill is so small that it's unimportant</td>
</tr>
<tr>
<td>3</td>
<td>Takes too much time (cleaning containers, etc.)</td>
</tr>
<tr>
<td>2</td>
<td>I've thought about it, but it's not important</td>
</tr>
<tr>
<td>13</td>
<td>Other</td>
</tr>
<tr>
<td>2</td>
<td>No Answer</td>
</tr>
</tbody>
</table>
Table 5.6 Aggregate Answers to the Survey Question ”What, if anything, prevents you, or whoever mows the lawn, from (grass-cycling)?”

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
</tr>
<tr>
<td>48</td>
</tr>
<tr>
<td>24</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>22</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

5.3 Multivariate Inferential Statistics

5.3.1 Factor Analyses

5.3.1.1 Recycling and Composting Behavior Factor Analysis

As noted above, factor analysis is a very powerful tool. In pure analytical terms, it is useful because it can enumerate the natural grouping of variables. The first set of variables that I ran through factor analysis was the self-reported waste management items, including items that can be recycled, those that cannot be recycled, composting items, and grass-cycling. The results of this initial analysis can be seen in Table 5.7. The number of factors retained in all of the factor analyses in this study were determined in near accordance with the Kaiser-Guzman rule, which is a very commonly used technique that dictates that any eigenvalue above 1.0 should be retained for further analysis (Brown, 2006). In some cases, I retained factors that had eigenvalues slightly below 1.0, but only if a) they were very close to 1.0 and b) they explained a relatively large proportion of the variance of the model. The cumulative variance explained by the factors can be seen in

---

30 All of the factor analyses and regression models were run through version 9.0 of jmp (SAS, 2008).
the “Cum Percent” column of the eigenvalue tables. Note that combined, the factors explain 100% of the variance of the set.

**Table 5.7 Factor Analysis Eigenvalues and Explanatory Power of Waste Management Behavior Variables**

<table>
<thead>
<tr>
<th>Number</th>
<th>Eigenvalue</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.3632</td>
<td>55.078</td>
<td>55.078</td>
</tr>
<tr>
<td>2</td>
<td>1.6933</td>
<td>9.960</td>
<td>65.038</td>
</tr>
<tr>
<td>3</td>
<td>1.5052</td>
<td>8.854</td>
<td>73.892</td>
</tr>
<tr>
<td>4</td>
<td>1.0305</td>
<td>6.062</td>
<td>79.954</td>
</tr>
<tr>
<td>5</td>
<td>0.6648</td>
<td>3.910</td>
<td>83.864</td>
</tr>
<tr>
<td>6</td>
<td>0.5463</td>
<td>3.214</td>
<td>87.078</td>
</tr>
<tr>
<td>7</td>
<td>0.4432</td>
<td>2.607</td>
<td>89.685</td>
</tr>
<tr>
<td>8</td>
<td>0.4175</td>
<td>2.456</td>
<td>92.141</td>
</tr>
<tr>
<td>9</td>
<td>0.2732</td>
<td>1.607</td>
<td>93.749</td>
</tr>
<tr>
<td>10</td>
<td>0.2517</td>
<td>1.481</td>
<td>95.229</td>
</tr>
<tr>
<td>11</td>
<td>0.2284</td>
<td>1.344</td>
<td>96.573</td>
</tr>
<tr>
<td>12</td>
<td>0.1529</td>
<td>0.899</td>
<td>97.473</td>
</tr>
<tr>
<td>13</td>
<td>0.1270</td>
<td>0.747</td>
<td>98.220</td>
</tr>
<tr>
<td>14</td>
<td>0.1099</td>
<td>0.647</td>
<td>98.866</td>
</tr>
<tr>
<td>15</td>
<td>0.0936</td>
<td>0.550</td>
<td>99.417</td>
</tr>
<tr>
<td>16</td>
<td>0.0580</td>
<td>0.341</td>
<td>99.758</td>
</tr>
<tr>
<td>17</td>
<td>0.0411</td>
<td>0.242</td>
<td>100.000</td>
</tr>
</tbody>
</table>

As Table 5.7 indicates, four factors were retained for the next step in the factor analysis, which is to determine the “factor loading” of the variables. After the number of factors is determined in the first step, the variables are “loaded” onto the designated number of factors, such that each factor has zero correlation to all of the other factors (Agresti & Finlay, 2003). The magnitude of the factor loadings delineate how well each variable correlates (the “loading” is in fact the correlation coefficient [Barr 2002]) to the factor. The higher the number, the better correlated the variable is to the given factor.
The coefficients range from zero to one, with a value of one indicating perfect correlation. Variables are grouped into factors that they are most highly correlated with.

One final note: factors are often “rotated” to make more meaningful factors with simpler structures (Agresti & Finlay 2003). Rotation usually results in more distinct factor loadings, and thus can clarify which variables to include on which factor. All of the factors in this analysis were rotated using the “varimax” rotation, which resulted in more distinct factors. The results of the factor loading analysis regarding waste management behavior can be seen in Table 5.8.

Table 5.8 Factor Loadings for Recycling/Composting Behavior

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>glass</td>
<td>0.9241401</td>
<td>0.18621</td>
<td>0.0827405</td>
<td>0.0979965</td>
</tr>
<tr>
<td>newspaper</td>
<td>0.9046115</td>
<td>0.1476946</td>
<td>0.0975286</td>
<td>0.1024271</td>
</tr>
<tr>
<td>plastic</td>
<td>0.868284</td>
<td>0.2491003</td>
<td>0.0522841</td>
<td>0.115852</td>
</tr>
<tr>
<td>aluminum</td>
<td>0.8788669</td>
<td>0.1856921</td>
<td>0.0846722</td>
<td>0.0866336</td>
</tr>
<tr>
<td>steel</td>
<td>0.9193965</td>
<td>0.1395712</td>
<td>0.1139237</td>
<td>-0.010703</td>
</tr>
<tr>
<td>aerosol</td>
<td>0.539952</td>
<td>0.3221652</td>
<td>0.3064227</td>
<td>-0.122813</td>
</tr>
<tr>
<td>cardboard</td>
<td>0.9046223</td>
<td>0.1447545</td>
<td>0.1321799</td>
<td>0.002601</td>
</tr>
<tr>
<td>paper board</td>
<td>0.9231305</td>
<td>0.1393414</td>
<td>0.1059004</td>
<td>0.0004518</td>
</tr>
<tr>
<td>mixed office</td>
<td>0.8808159</td>
<td>0.1669987</td>
<td>0.1211275</td>
<td>-0.022931</td>
</tr>
<tr>
<td>magazines &amp; catalogs</td>
<td>0.9117584</td>
<td>0.1389966</td>
<td>0.085333</td>
<td>-0.022863</td>
</tr>
<tr>
<td>phone books</td>
<td>0.8077693</td>
<td>0.1371269</td>
<td>0.012198</td>
<td>-0.017191</td>
</tr>
<tr>
<td>plastic bags at home</td>
<td>0.0674065</td>
<td>0.7673417</td>
<td>0.051901</td>
<td>0.3341462</td>
</tr>
<tr>
<td>packaging</td>
<td>0.2959037</td>
<td>0.7631579</td>
<td>0.0454336</td>
<td>-0.169291</td>
</tr>
<tr>
<td>plastic tubs</td>
<td>0.2621159</td>
<td>0.7609873</td>
<td>0.0357056</td>
<td>-0.139657</td>
</tr>
<tr>
<td>kitchen waste</td>
<td>0.188942</td>
<td>0.0793141</td>
<td>0.9161866</td>
<td>-0.044577</td>
</tr>
<tr>
<td>yard waste</td>
<td>0.0725964</td>
<td>0.0217792</td>
<td>0.9119898</td>
<td>0.1841447</td>
</tr>
<tr>
<td>grass-cycle</td>
<td>0.10124</td>
<td>-0.041737</td>
<td>0.104383</td>
<td>0.9207302</td>
</tr>
<tr>
<td>Cronbach’s Alpha</td>
<td>0.9732</td>
<td>0.7011</td>
<td>0.8521</td>
<td>n/a</td>
</tr>
</tbody>
</table>
This factor analysis had expected results. Namely, the four factors that resulted neatly divided the behavioral variables into intuitive groups. Factor 1 is loaded with all of the variables that related to items that are allowable in recycling bins in Denver. This means that the sample population reports recycling these items with similar frequency, though it should be pointed out that aerosol cans had a much lower loading than the other items. This is to be expected, as Figure 5.1 indicates that aerosol cans were not recycled more often than they were, on the average. Factor 2 contains the three items included in the questionnaire (plastic bags, plastic tubs and packaging) that are not to be placed in the bins. It is important to point out that Figure 5.1 indicated that plastic bags were recycled at nearly the same rate as allowable materials, but that the factor analysis is a much more rigorous analytical tool than simple descriptive statistics, and also that factor analysis is an inferential statistic, and implies the behavioral frequency of the study population (not sample), which in this case are all of the residents of the nine census tracts surveyed. This likely accounts for the discrepancy. The third factor consists of the composting variables, and the fourth factor contains only one variable, grass-cycling. All of these factors have an acceptable magnitude of “cronbach’s alpha,” which is a measure of internal consistency of the factor. A higher alpha indicates highly correlated variables within the factor\(^\text{31}\). The four resulting factors are listed in Table 5.9.

<table>
<thead>
<tr>
<th>Table 5.9 Waste Management Behavior Factors as Determined by Factor Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 1:</strong> Recycling Behavior</td>
</tr>
<tr>
<td><strong>Factor 2:</strong> Errant Recycling Behavior</td>
</tr>
<tr>
<td><strong>Factor 3:</strong> Composting Behavior</td>
</tr>
<tr>
<td><strong>Factor 4:</strong> Grass-cycling</td>
</tr>
</tbody>
</table>

\(^{31}\) Cronbach’s alpha is not valid for Factor 4, because grass-cycling is the only factor, thus a measure of internal consistency is redundant.
The results of this factor analysis will be used to determine the structure of the
dependent variables in the behavioral model. Only factors 1 and 3 were considered in
this analysis, as they are the two most impactful waste management behaviors and have
been the focus of the research from the outset. It would perhaps be instructive to
determine the correlates of errant recycling behavior, but it is a less important construct
than proper recycling behavior. Likewise for grass-cycling. As noted previously, there
are many possible analytical uses for the data gathered for this study, but the research
scope must be limited to a reasonable extent. Regardless, this analysis demonstrates the
usefulness and power of factor analysis. First of all, it greatly simplified the behavioral
model by reducing the dependent variables from thirteen to two. Granted, these thirteen
variables could have been combined into two groups/factors intuitively. The fact that
factor analysis *objectively* placed the variables into these groups significantly strengthens
the rationale for the groupings, thus lending more legitimacy (i.e. reducing caveats) to the
analysis, which is another benefit of factor analysis.

5.3.1.2 NEP Factor Analysis

The eight questions that consisted of the modified NEP scale used by Barr (2002)
and Barr and Gilg (2005) were also subjected to factor analysis in order to determine
their dimensionality. The literature contains many examples of NEP scales being
unidimensional (e.g. Dunlap & Van Liere 1978; Dunlap et al. 2000) and
multidimensional (e.g Albrecht et al. 1982). Though the NEP scale is designed so that all
of the items are correlated, the diversity of results of previous studies indicates the need
to examine the scale to determine if it should be divided among factors. Table 5.10
shows the results of the factor analysis. I chose to retain three factors instead of the two that would be dictated by the Kaiser-Guzman rule for two reasons. First, the third factor had a value very close to 1 (0.917). Secondly, by adding the third factor, over 11% of additional variance was explained and only 55% of the variance was explained by the first two factors. This indicates that this third factor has relatively high explanatory capabilities. Taking these factors into consideration, I ran a varimax rotation with three factors, the results of which can be seen in Table 5.11.

Table 5.10 Principal Component Eigenvalues and Explanatory Power of NEP Variables

<table>
<thead>
<tr>
<th>Number</th>
<th>Eigenvalue</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.1626</td>
<td>39.532</td>
<td>39.532</td>
</tr>
<tr>
<td>2</td>
<td>1.2381</td>
<td>15.477</td>
<td>55.009</td>
</tr>
<tr>
<td>3</td>
<td>0.9107</td>
<td>11.383</td>
<td>66.392</td>
</tr>
<tr>
<td>4</td>
<td>0.7078</td>
<td>8.848</td>
<td>75.240</td>
</tr>
<tr>
<td>5</td>
<td>0.6456</td>
<td>8.069</td>
<td>83.310</td>
</tr>
<tr>
<td>6</td>
<td>0.5616</td>
<td>7.020</td>
<td>90.330</td>
</tr>
<tr>
<td>7</td>
<td>0.4196</td>
<td>5.245</td>
<td>95.575</td>
</tr>
<tr>
<td>8</td>
<td>0.3540</td>
<td>4.425</td>
<td>100.000</td>
</tr>
</tbody>
</table>
### Table 5.11 Factor Loadings for NEP Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The environment is forgotten too often when decisions are made</td>
<td>0.8117935</td>
<td>0.172387</td>
<td>0.1243499</td>
</tr>
<tr>
<td>If we over-use our natural resources, human development may be harmed</td>
<td>0.7511544</td>
<td>0.2438643</td>
<td>0.1596332</td>
</tr>
<tr>
<td>Nature isn’t harmed by human changes* (NEP 5)</td>
<td>0.7310257</td>
<td>-0.092531</td>
<td>0.1361963</td>
</tr>
<tr>
<td>Nature and the environment have as much value as human beings</td>
<td>0.4991756</td>
<td>0.5930202</td>
<td>0.2151102</td>
</tr>
<tr>
<td>Humans should not develop any more resources or land, in order to</td>
<td>0.3561165</td>
<td>0.6718876</td>
<td>0.0086224</td>
</tr>
<tr>
<td>protect the natural environment (NEP 4)</td>
<td>-0.166457</td>
<td>0.7859175</td>
<td>0.2155658</td>
</tr>
<tr>
<td>Human welfare should be our primary concern in the future* (NEP 6)</td>
<td>0.2988518</td>
<td>0.0044305</td>
<td>0.8092205</td>
</tr>
<tr>
<td>The environment is of little concern to me* (NEP 7)</td>
<td>0.062105</td>
<td>0.3116617</td>
<td>0.7962785</td>
</tr>
<tr>
<td>Getting through daily life and surviving is what concerns me the</td>
<td>0.7219</td>
<td>0.6013</td>
<td>0.5734</td>
</tr>
<tr>
<td>most, not the environment* (NEP 8)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*reverse coded

As can be seen in Table 5.11, the variables were nearly evenly divided among the factors. The internal correlation of the factors, as indicated by the alpha value, are middling, but acceptable. This lack of internal consistency is not surprising considering the relatively low level of cumulative explanation by the factors (66.4%), and that the means (Table 5.12) show that factors 2 and 3 have items whose means do not match up very well. The variables are shown to be multidimensional, so it was useful to run this analysis instead of accepting the purported unidimensionality of the NEP scale. Upon close inspection, the variables have been divided into related and intuitive groups/factors. Factor one can be considered “Pragmatic Environmentalism,” which consists of less controversial propositions that the environment should be considered when decisions are made, human development depends on proper use of natural resources, and that nature
can be harmed by human changes. The second factor can be termed “Deep Ecology” because it contains constructs that are border on valuing nature more than humans.

Finally, Factor 3 is termed “Enviro-centrism” because it contains two items that center on (not) holding the environment as a central personal concern. The NEP factors are listed in Table 5.13.

**Table 5.12 Mean Scores for NEP Item Questions**

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEP 1</td>
<td>4.21</td>
</tr>
<tr>
<td>NEP 2</td>
<td>4.56</td>
</tr>
<tr>
<td>NEP 3</td>
<td>4.09</td>
</tr>
<tr>
<td>NEP 4</td>
<td>3.02</td>
</tr>
<tr>
<td>NEP 5</td>
<td>4.60</td>
</tr>
<tr>
<td>NEP 6</td>
<td>2.81</td>
</tr>
<tr>
<td>NEP 7</td>
<td>4.61</td>
</tr>
<tr>
<td>NEP 8</td>
<td>3.86</td>
</tr>
</tbody>
</table>

**Table 5.13 NEP Factors as Determined by Factor Analysis**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1:</td>
<td>Pragmatic Environmentalism</td>
</tr>
<tr>
<td>Factor 2:</td>
<td>Deep Ecology</td>
</tr>
<tr>
<td>Factor 3:</td>
<td>Enviro-centrism</td>
</tr>
</tbody>
</table>

**5.3.1.3 Psychological Variable Factor Analysis**

The final two factor analyses were undertaken to analyze the relationship between the psychological variables concerning recycling on the one hand, and composting on the other. Variables related to habit strength, attitude, awareness of norm, acceptance of norm, personal efficacy and response efficacy were entered into each factor analysis.

Table 5.14 and Table 5.15 show the eigenvalues for the recycling and composting
psychological factors\textsuperscript{32}. Note that the psychological constructs are indicated in both tables. Four factors were retained for each set of variables.

Table 5.14 Principal Component Eigenvalues and Explanatory Power of Recycling Psychological Variables

<table>
<thead>
<tr>
<th>Number</th>
<th>Eigenvalue</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.3215</td>
<td>53.912</td>
<td>53.912</td>
</tr>
<tr>
<td>2</td>
<td>2.0932</td>
<td>9.967</td>
<td>63.88</td>
</tr>
<tr>
<td>3</td>
<td>1.158</td>
<td>5.514</td>
<td>69.394</td>
</tr>
<tr>
<td>4</td>
<td>0.9834</td>
<td>4.683</td>
<td>74.077</td>
</tr>
<tr>
<td>5</td>
<td>0.7787</td>
<td>3.708</td>
<td>77.785</td>
</tr>
<tr>
<td>6</td>
<td>0.6902</td>
<td>3.287</td>
<td>81.072</td>
</tr>
</tbody>
</table>

Table 5.15 Principal Component Eigenvalues and Explanatory Power of Composting Psychological Variables

<table>
<thead>
<tr>
<th>Number</th>
<th>Eigenvalue</th>
<th>Percent</th>
<th>Cum Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.5985</td>
<td>50.469</td>
<td>50.469</td>
</tr>
<tr>
<td>2</td>
<td>1.8427</td>
<td>8.775</td>
<td>59.244</td>
</tr>
<tr>
<td>3</td>
<td>1.3932</td>
<td>6.634</td>
<td>65.878</td>
</tr>
<tr>
<td>4</td>
<td>1.2055</td>
<td>5.741</td>
<td>71.619</td>
</tr>
<tr>
<td>5</td>
<td>0.8664</td>
<td>4.126</td>
<td>75.745</td>
</tr>
<tr>
<td>6</td>
<td>0.7790</td>
<td>3.709</td>
<td>79.454</td>
</tr>
</tbody>
</table>

The factor loadings for each set of variables can be seen in Table 5.16 and Table 5.17. The loadings are clear, and with the exception of Factor 4 in each set, the internal consistency is strong, as evidenced by the Cronbach’s alpha value. For the recycling psychological variables, Factor 1 loads distinctly and strongly with the 12 SRHI items, having high internal consistency (Cronbach’s alpha = 0.9656). Factor 2 contains a mixture of constructs, including ones related to attitude, response efficacy, perceived

\textsuperscript{32} Note that in the interest of brevity, some factors are left out of the tables, as they are not important in regards to this analysis.
convenience, attitude, and personal efficacy. It is not clear why these constructs all loaded onto one factor, as other studies (e.g. Barr 2002; Chen & Tung 2010) found that these psychological variables were statistically distinct in terms of factor loading. It is possible that the limited number of questions addressing each construct influenced their correlation. Regardless, the factor has high internal consistency (Cronbach’s alpha = 0.8498), and will be used. Factors 3 and 4 each contains the two variables related to norm acceptance and norm awareness, respectively. Factor 3 has very strong internal consistency (Cronbach’s alpha = 0.9202), but Factor 4’s is quite low (0.4887). The latter finding is curious, because the questions used to address norm acceptance are very similar and should load consistently. Regardless, all four factors were kept for the regression analysis.
### Table 5.16 Factor Loadings for Recycling Psychological Variables

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH – I do frequently (HABIT)</td>
<td>0.671956</td>
<td>0.452379</td>
<td>-0.04945</td>
<td>0.349855</td>
</tr>
<tr>
<td>RH – I do automatically (HABIT)</td>
<td>0.745673</td>
<td>0.380275</td>
<td>-0.03205</td>
<td>0.39205</td>
</tr>
<tr>
<td>RH – I do without having to consciously remember (HABIT)</td>
<td>0.76804</td>
<td>0.376845</td>
<td>-0.02415</td>
<td>0.356891</td>
</tr>
<tr>
<td>RH – that makes me feel weird if I do not do it (HABIT)</td>
<td>0.664535</td>
<td>0.464668</td>
<td>0.042786</td>
<td>0.139477</td>
</tr>
<tr>
<td>RH – I do without thinking (HABIT)</td>
<td>0.821375</td>
<td>0.363767</td>
<td>0.001754</td>
<td>0.202669</td>
</tr>
<tr>
<td>RH – that would require effort nor to do it (HABIT)</td>
<td>0.772614</td>
<td>0.296614</td>
<td>0.019482</td>
<td>-0.05372</td>
</tr>
<tr>
<td>RH – that belongs to my daily routine (HABIT)</td>
<td>0.713469</td>
<td>0.535168</td>
<td>0.019064</td>
<td>0.221131</td>
</tr>
<tr>
<td>RH – I start before I realize I’m doing it (HABIT)</td>
<td>0.835107</td>
<td>0.277003</td>
<td>-0.03369</td>
<td>0.131993</td>
</tr>
<tr>
<td>RH – I would find hard not to do (HABIT)</td>
<td>0.748071</td>
<td>0.416692</td>
<td>0.061452</td>
<td>0.086631</td>
</tr>
<tr>
<td>RH – I have no need to think about doing (HABIT)</td>
<td>0.786283</td>
<td>-0.04983</td>
<td>-0.02722</td>
<td>-0.12588</td>
</tr>
<tr>
<td>RH – That’s typically &quot;me&quot; (HABIT)</td>
<td>0.767307</td>
<td>0.37635</td>
<td>0.070908</td>
<td>0.158923</td>
</tr>
<tr>
<td>RH – I have been doing a long time (HABIT)</td>
<td>0.777166</td>
<td>0.332507</td>
<td>-0.01614</td>
<td>0.277614</td>
</tr>
<tr>
<td>Is recycling an important issue to you? (ATTITUDE)</td>
<td>0.491798</td>
<td>0.666233</td>
<td>0.019626</td>
<td>0.113151</td>
</tr>
<tr>
<td>Recycling is easy (PERCEIVED CONVENIENCE)</td>
<td>0.477296</td>
<td>0.549176</td>
<td>-0.02451</td>
<td>0.230533</td>
</tr>
<tr>
<td>I do not create enough waste to justify recycling (RESPONSE EFFICACY)</td>
<td>0.201551</td>
<td>0.732479</td>
<td>0.192617</td>
<td>0.064317</td>
</tr>
<tr>
<td>Recycling is too time-consuming to worry about (PERCEIVED CONVENIENCE, ATTITUDE)</td>
<td>0.336052</td>
<td>0.783839</td>
<td>0.076532</td>
<td>0.106853</td>
</tr>
<tr>
<td>Recycling on a daily basis is possible for me (PERSONAL EFFICACY)</td>
<td>0.278438</td>
<td>0.684299</td>
<td>-0.05799</td>
<td>0.204046</td>
</tr>
<tr>
<td>Generally speaking, it is important that my friends/family approve of what I do (NORM ACCEPTANCE)</td>
<td>-0.06255</td>
<td>0.04846</td>
<td>0.941501</td>
<td>0.106648</td>
</tr>
<tr>
<td>Generally speaking, it is important that those who are important to me approve of what I do (NORM ACCEPTANCE)</td>
<td>0.038563</td>
<td>0.079882</td>
<td>0.948206</td>
<td>0.123071</td>
</tr>
<tr>
<td>Most of my friend/family recycle (NORM AWARENESS)</td>
<td>0.146985</td>
<td>0.221103</td>
<td>0.029723</td>
<td>0.754448</td>
</tr>
<tr>
<td>Most people who are important to me think that I should recycle (NORM AWARENESS)</td>
<td>0.097183</td>
<td>0.063705</td>
<td>0.227356</td>
<td>0.710807</td>
</tr>
<tr>
<td>Cronbach’s Alpha</td>
<td>0.9656</td>
<td>0.8498</td>
<td>0.9202</td>
<td>0.4887</td>
</tr>
</tbody>
</table>

Table 5.17 shows the factor loading for the composting psychological constructs.

The factors are strikingly similar to those found in the recycling analysis. Factor 1
contains the composting-related SRHI questions and the perceived convenience variable. Factor 2 for composting contains the same items as Factor 2 in recycling, with the exception of one of the convenience items being loaded with the habit constructs. Composting Factor 2 will also be termed “efficacy, attitude and convenience.” Factors 3 and 4 for composting are the same as they are for recycling, namely “acceptance of norms” and “norm awareness,” respectively. Factors 1 and 2 have very high internal consistency (greater than 0.9 Cronbach’s alpha), while Factors 2 and 4 are less reliable, having Cronbach’s alpha values of 0.6709 and 0.5845, respectively. All of these factors (four factors each for recycling and composting) were retained for regression analysis, and are listed in Table 5.18.
Table 5.17 Factor Loadings for Composting Psychological Variables

<table>
<thead>
<tr>
<th>Factor</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH – I do frequently (HABIT)</td>
<td>0.8865864</td>
<td>0.2413836</td>
<td>-0.059466</td>
<td>0.1234226</td>
</tr>
<tr>
<td>CH – I do automatically (HABIT)</td>
<td>0.9321222</td>
<td>0.1813804</td>
<td>-0.078378</td>
<td>0.0972677</td>
</tr>
<tr>
<td>CH – I do without having to consciously remember (HABIT)</td>
<td>0.9226214</td>
<td>0.1916714</td>
<td>-0.064644</td>
<td>0.1007789</td>
</tr>
<tr>
<td>CH – that makes me feel weird if I do not do it (HABIT)</td>
<td>0.7902375</td>
<td>0.3270518</td>
<td>-0.006588</td>
<td>0.0115627</td>
</tr>
<tr>
<td>CH – I do without thinking (HABIT)</td>
<td>0.9367738</td>
<td>0.1698252</td>
<td>-0.058109</td>
<td>0.0724625</td>
</tr>
<tr>
<td>CH – that belongs to my daily routine (HABIT)</td>
<td>0.6210664</td>
<td>0.1324116</td>
<td>-0.144755</td>
<td>-0.017558</td>
</tr>
<tr>
<td>CH – I start before I realize I’m doing it (HABIT)</td>
<td>0.857031</td>
<td>0.2502645</td>
<td>-0.059979</td>
<td>0.0950409</td>
</tr>
<tr>
<td>CH – I would find hard not to do (HABIT)</td>
<td>0.8006587</td>
<td>0.259664</td>
<td>-0.141009</td>
<td>-0.022004</td>
</tr>
<tr>
<td>CH – I have no need to think about doing (HABIT)</td>
<td>0.6433407</td>
<td>-0.19532</td>
<td>-0.097642</td>
<td>-0.021675</td>
</tr>
<tr>
<td>CH – That’s typically &quot;me&quot; (HABIT)</td>
<td>0.7438303</td>
<td>0.3420552</td>
<td>-0.122803</td>
<td>0.0018286</td>
</tr>
<tr>
<td>CH – I have been doing a long time (HABIT)</td>
<td>0.8817799</td>
<td>0.1990851</td>
<td>-0.132584</td>
<td>0.100724</td>
</tr>
<tr>
<td>Composting is easy (PERCEIVED CONVENIENCE)</td>
<td>0.5864121</td>
<td>0.4066541</td>
<td>-0.138174</td>
<td>0.0436069</td>
</tr>
<tr>
<td>Composting on a daily basis is possible for me (PERSONAL EFFICACY)</td>
<td>0.3822822</td>
<td>0.5070212</td>
<td>-0.180061</td>
<td>0.0641885</td>
</tr>
<tr>
<td>I do not create enough waste to justify composting (RESPONSE EFFICACY)</td>
<td>0.0104235</td>
<td>0.7196268</td>
<td>0.0667493</td>
<td>0.0496373</td>
</tr>
<tr>
<td>Is composting an important issue to you? (ATTITUDE)</td>
<td>0.5202613</td>
<td>0.5265932</td>
<td>-0.006959</td>
<td>0.0609108</td>
</tr>
<tr>
<td>Composting is too time-consuming to worry about (PERCEIVED CONVENIENCE, ATTITUDE)</td>
<td>0.3880645</td>
<td>0.6883754</td>
<td>-0.055847</td>
<td>0.0699395</td>
</tr>
<tr>
<td>Generally speaking, it is important that my friends/family approve of what I do (NORM ACCEPTANCE)</td>
<td>-0.137992</td>
<td>-0.039891</td>
<td>0.9464576</td>
<td>0.0367334</td>
</tr>
<tr>
<td>Generally speaking, it is important that those who are important to me approve of what I do (NORM ACCEPTANCE)</td>
<td>-0.149113</td>
<td>-0.018729</td>
<td>0.9438113</td>
<td>0.0184062</td>
</tr>
<tr>
<td>Most people who are important to me think that I should compost (NORM AWARENESS)</td>
<td>0.017118</td>
<td>0.1851204</td>
<td>0.0285498</td>
<td>0.8228005</td>
</tr>
<tr>
<td>Most of my friend/family compost (NORM AWARENESS)</td>
<td>0.1231133</td>
<td>-0.036733</td>
<td>0.0197846</td>
<td>0.8423652</td>
</tr>
<tr>
<td>Cronbach’s Alpha</td>
<td>0.9648</td>
<td>0.6709</td>
<td>0.9202</td>
<td>0.5845</td>
</tr>
</tbody>
</table>
Table 5.18 Recycling and Composting Psychological Variable Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Recycling</th>
<th>Composting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1:</td>
<td>Recycling Habit</td>
<td>Composting Habit</td>
</tr>
<tr>
<td>Factor 2:</td>
<td>Efficacy, Convenience and Attitude</td>
<td>Efficacy, Convenience and Attitude</td>
</tr>
<tr>
<td>Factor 3:</td>
<td>Acceptance of Norms</td>
<td>Acceptance of Norms</td>
</tr>
<tr>
<td>Factor 4:</td>
<td>Recycling Norm Awareness</td>
<td>Composting Norm Awareness</td>
</tr>
</tbody>
</table>

5.3.1.4 Summary of Factor Analyses

After the factor analyses, each behavioral outcome (self-reported recycling and composting behavior) has seven variables that are to be tested for their impact and integrated into the behavioral model. The NEP variables, which have been found to load onto three factors, will each be entered into the regression for both recycling and composting. Each behavior also has the same four psychological variables each that will be analyzed, though note that the variables within the first two factors (Habit and Efficacy, Convenience and Attitude) vary slightly between the composting and recycling factors. The seven factors are as follows:

- Factor 1: Pragmatic Environmentalism
- Factor 2: Deep Ecology
- Factor 3: Enviro-centrism
- Factor 4: Composting/Recycling Habit
- Factor 5: Efficacy, Convenience and Attitude
- Factor 6: Acceptance of Norms
- Factor 7: Composting/Recycling Norm Awareness
Other variables will be tested for their impact on self-reported behavior, as noted previously – namely, demographics, actual convenience and concrete knowledge (CK) for recycling; and demographics and home gardening status for composting. These variables are situational variables, and thus were not included in the psychological variable factor analysis. The logic behind this is that situational variables are not impacted by each other or by psychological variables, nor are dependent on perception of the individual. The latter is most important, because all of the psychological variables are based on perception. Some demographic variables can be dictated by the individual (e.g. education level), but once achieved, they are not changed according to how one “thinks about it,” as psychological variables are. Concrete knowledge is also obviously within the control of the individual, but again, it is not dependent upon perception. The additional variables that will be entered into the model are as follows:

- Socio-demographics (gender, age group, education level, housing type, homeownership)
- Concrete knowledge (recycling only)
- Actual convenience (having a curbside bin or not; for recyclers only)
- Having a home garden or not (for composting only)

Of these variables, gender, housing type, rent/own and having a curbside bin are nominal variable; and age group and education level are ordinal. To prepare these variables for regression analysis, “dummy variables” were created. Dummy variables act as continuous proxies to nominal or ordinal data, and thus can be analyzed in regression analyses.33

---

33 Note that if dummy variables are not created by the analyst, they will automatically be created by jmp, which is the software used in this analysis.
(Stockburger n.d.; McDonald 2009). I created dummy variables that had values of zero or one, as follows:

- **Gender:** female = 1, male = 0
- **Age Group:** age 40 or older = 1, under the age of 40 = 0
- **Education Level:** bachelor’s degree or higher = 1, other = 0
- **Housing Type:** single family detached = 1, other = 0
- **Homeownership:** homeowner = 1, renter = 0
- **Actual Convenience:** has large recycling bin with wheels = 1, other = 0
- **Having a Home Garden:** has a garden = 1, no garden = 0
- **Income level:** more than $50,000 = 1, $50,000 or less = 0

Note that gender, housing type, convenience, homeownership and home gardening are categorical, i.e. they do not imply valuation. However, age group and education level are ordinal, thus a higher number indicates “more” of each variable.

Concrete knowledge was derived based on the answers to three questions on the survey. Question 12 asked how often curbside recycling got picked up. Question 15 asked if materials needed to be separated when put in the recycling bin. For both of these, a correct answer was worth one point. Question 14 listed 14 items and asked which of the items could be recycled. Nine of the items are recyclable, and 5 are not (“I don’t know” was also an allowable response). In order to weight this question equally with the other two CK questions, an intra-question score was generated – each correct
answer was worth one point, each incorrect answer worth negative one point. The best possible score was nine points, so the intra-questions score was divided by nine to generate the overall question score. An answer of “I don’t know” was worth zero points. Thus, all three CK questions were worth one point each. The totals were summed, and normalized to a 1-point interval scale by dividing by 3.

5.3.2 Regression Analysis

The final step in deriving the behavioral models is to integrate all of the independent and dependent variables into a regression model. A regression model is a very useful tool for social (and physical) scientists, because as noted above it has the ability to take a large number of independent variables and measure their impact on a dependent variable. For this study, I chose to utilize a stepwise regression tool. Stepwise regression adds one variable at a time and quantifies the impact it has on the dependent and the independent variables. It continuously adds variables, each time measuring the impact on all of the variables. After numerous iterations, a stepwise regression retains only those variables that have a (user-defined) significant impact on the outcome (Agresti & Finlay 2003; McDonald 2009). The stepwise regression removes unnecessary variables, which in this study I defined as those variables not having a statistically significant (p < 0.05) influence on the dependent variable(s). The simplified results of the recycling behavior stepwise regression can be seen in Table 5.19.

---

34 It is -1 instead of 0 because it prevented a respondent from getting a perfect score by checking all the boxes.
Table 5.19 Regression Analysis Results for Recycling Behavior

<table>
<thead>
<tr>
<th>Retained</th>
<th>Parameter</th>
<th>F Ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Intercept</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>X</td>
<td>Total CK score</td>
<td>22.786</td>
<td>3.56E-06</td>
</tr>
<tr>
<td>X</td>
<td>Large bin</td>
<td>8.835</td>
<td>0.00333</td>
</tr>
<tr>
<td></td>
<td>NEP 1 - pragmatic environmentalism</td>
<td>0.251</td>
<td>0.61679</td>
</tr>
<tr>
<td></td>
<td>NEP 2 - deep ecology</td>
<td>1.03</td>
<td>0.31132</td>
</tr>
<tr>
<td></td>
<td>NEP 3 - enviro-centrism</td>
<td>1.818</td>
<td>0.17913</td>
</tr>
<tr>
<td></td>
<td>Acceptance of norm factor</td>
<td>1.232</td>
<td>0.26837</td>
</tr>
<tr>
<td></td>
<td>Knowledge of recycling norm</td>
<td>0.081</td>
<td>0.77691</td>
</tr>
<tr>
<td>X</td>
<td>Recycling efficacy, attitude and convenience</td>
<td>21.275</td>
<td>7.21E-06</td>
</tr>
<tr>
<td>X</td>
<td>Recycling habit</td>
<td>65.082</td>
<td>7.30E-14</td>
</tr>
<tr>
<td></td>
<td>40 years or older?</td>
<td>0.04</td>
<td>0.84084</td>
</tr>
<tr>
<td></td>
<td>Gender</td>
<td>0.863</td>
<td>0.35416</td>
</tr>
<tr>
<td></td>
<td>Bachelor's or higher</td>
<td>0.01</td>
<td>0.92155</td>
</tr>
<tr>
<td></td>
<td>Income above $50,000</td>
<td>0.323</td>
<td>0.57034</td>
</tr>
<tr>
<td></td>
<td>Rent/own</td>
<td>0.227</td>
<td>0.63397</td>
</tr>
<tr>
<td></td>
<td>Detached house?</td>
<td>2.152</td>
<td>0.14401</td>
</tr>
</tbody>
</table>

As noted above, I chose to keep only those variables that had a p < 0.05. The column labeled “Retained” indicates which variables are to be kept for the next analytical step.

After the stepwise regression determines which variables to retain, the final step in ascertaining the impact of the variables on the measurement variable is to run a simpler “multiple regression” (Barr 2002). The most common linear regression technique is “least square.” The goal of linear regression is to integrate the predictor variables into an equation that best matches the actual data points if they were plotted on a graph. Figure 5.16 shows the regression line (the straight red line) and data points for the four variables that were retained for analysis on recycling behavior. It should be apparent that the regression line is drawn in such a way as to closely mimic the pattern of the data points.
This is a result of the least squares regression. Least squares calculates the equation and line that best fits the data points by calculating the squared distance between the points and the regression line. The greater the aggregate distance between the points and the line, the worse the regression equation fits the data points. By minimizing the sum of squares, least squares regression derives the best-fitting linear equation, and thus maximizes the explanatory power of the equation (McDonald 2009).

![Figure 5.16 Linear Regression Line and Data Points for Recycling Behavior Regression Model](image)

Figure 5.16 also shows an important statistic – the r-squared ($r^2$) value (it appears as “RSq” in the figure). The $r^2$ value quantifies the percent of the variance of the dependent variable that results from integration of the independent variables into the regression equation. In essence, it shows how much of the outcome (in this case, recycling behavior) can be predicted by the independent variables. This model has an $r^2$ of 0.82, which means that approximately 82% of the variance in recycling behavior can be predicted if the value of the four explanatory variables is known. It is clear from the scatterplot that the line is a relatively good fit, and the residuals appear to be low. Note also that the regression equation has an extremely high confidence level, $p < 0.0001$. 

92
The final component of the behavioral model can be seen in Table 5.20. This statistic is called the “beta weight.” The beta weight is a number between 0 and 1, and represents the magnitude of standard deviation that the dependent variable would change if the dependent variable were to increase by one standard deviation (Barr, 2002). For example, if the Concrete Knowledge score for a given respondent would increase by one standard deviation (3.7, the mean is 6.3 on a scale of 1-10), it would be expected that the recycling score would increase by 0.241225 standard deviations. The recycling score standard deviation is 15.73, so an increase in one standard deviation of the CK score should result in an increase of approximately 3.79 in the recycling score. Of course, this is only an approximation – it is the expected value, but as Figure 5.16 clearly shows, this will not always be accurate. Table 5.20 shows the beta weights for all of the independent variables in the recycling and composting behavioral models. Note that composting behavior is not explained as well by its independent variables as recycling is, though at over 62% explanatory power, the regression is nonetheless rather powerful. Also note the “error term,” which quantifies the explanatory strength of all variables not included in the behavioral model. It can be thought of as the beta weight of the aggregate of all unseen variables, both those included in the original analysis and not considered in the analysis.
The benefit of using beta values for the behavioral models instead of the regression coefficients is that beta values are normalized to a 0 – 1 scale, whereas regression coefficients reflect the magnitude of the scales that the variables were measured in. For example, in the recycling model, Concrete Knowledge scores ranged from 0 – 10, whereas a respondent could score anywhere from 5 to 25 on the Efficacy, Convenience and Attitude (ECA) score. As a result, even though the beta weights of these two variables are approximately equal (~0.24), the regression coefficients are 1.02 and 1.08 (6% difference) for CK score and ECA score, respectively. Beta weights rescale the explanatory variables so that the magnitude of the numbers can be compared simply and intuitively. The beta weights for recycling and composting have been

---

35 Note that the scores were summed, not averaged. The Efficacy, Convenience and Attitude score was the sum of 5 items with each item having a scale of 1 – 5, hence the total score could be anywhere from 5 to 25.

36 These are rounded scores. The actual beta weights are 2.5% different.
integrated into separate recycling and composting behavioral models (Figure 5.17 and Figure 5.18). In order to make the model easier to interpret, arrow and line weights reflect the relative explanatory power of the variable (thicker line means a higher beta value) and negative correlations are indicated by a dotted line (Barr 2002). The error term is indicated by the “e” symbol.

Figure 5.17 Recycling Behavioral Model

Figure 5.18 Composting Behavioral Model

5.3.3 Cluster Analysis

Finally, a cluster analysis, which is another multivariate inferential statistic, was run with the intention of further explaining the correlates of recycling and composting
behavior. Cluster analysis is a statistical procedure that takes large groups of data points and groups them together based on similar values of measured variables (Barr, Gilg and Ford 2005). This feature is available on jmp© as well. The software combines data points one at a time, grouping them into clusters sharing similar values for given variables, then combining clusters that are closest in value, until all data points are in one cluster. The number of clusters thus progress from n to 1, and it is up to the researcher to decide at what point (usually before all points are combined) to accept the number of the groups. The groups can then be analyzed to determine if the groupings make sense and are statistically significant. For this research, the data points are individual surveys/respondents and a cluster analysis can group them based on any number of variables. The result of the cluster analysis detailed below is groupings of survey respondents that share similar scores on the self-reported behavior constructs, with the goal being to describe to the statistically significant extent possible the demographic characteristics of “typical” (non) recycler and/or (non) composter.

The diagrams and plots in Figure 5.19 show the results of the cluster analysis. The variables that were clustered were the eleven recyclable material options and the two composting items. Thus, the data points are grouped together based on similar scores for these thirteen behaviors. The large charts are called “dendrograms”, and they allow the user to visualize the iterative combining of the individual points. Notice that the number of horizontal lines (representing points and ultimately clusters) decrease going from left to right – this visually demonstrates the combining of points, then clusters until one cluster results. The dendrogram on the right shows the three color-coded clusters that
resulted from this analysis. The number of clusters was chosen based on the information provided in Table 5.21, which is the “clustering history.” This table shows in a numeric manner the progressive combining of clusters. Note that the “scree plot” (beneath the dendrograms in Figure 5.19) is a graphical representation of the cluster history. It is generally recommended to choose a number of clusters at a point where the scree plot slope increases abruptly, as evidenced by a rapid increase in the “distance” value in the cluster history. Recall that cluster analysis combines data based on similarity of scores on designated variables. “Distance” refers to the difference in these scores, thus the greater the distance, the lower the level of similarity, and the less reliable the clusters are likely to be. This is the reason that clusters are “cut off” when the distance begins to increase abruptly – it indicates increasing dissimilarity in the variables. Based on this, I chose to retain three clusters.
The three clusters consist of a number of respondents that had similar responses to the recycling and composting questions on the survey. The clusters, detailed in Table 5.22, clearly represent three distinct groups: Avid Recyclers & Composters (ARC) (high
recycling and composting scores), Avid Recyclers (ARs) (high recycling score, low composting score) and Poor Waste Managers (PWMs) (low scores for recycling and composting. These groups can easily be distinguished by the differing mean scores on the recycling and composting questions.

Table 5.22 Recycling and Composting Behavioral Levels of Respondent Clusters

<table>
<thead>
<tr>
<th>Cluster</th>
<th>N</th>
<th>Recycling Mean Score</th>
<th>Composting Mean Score</th>
<th>Generalized Recycling Score</th>
<th>Generalized Compost Score</th>
<th>Group Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>4.73</td>
<td>3.78</td>
<td>High</td>
<td>High</td>
<td>Avid Recyclers and Composters</td>
</tr>
<tr>
<td>2</td>
<td>102</td>
<td>4.34</td>
<td>1.31</td>
<td>High</td>
<td>Low</td>
<td>Avid Recyclers</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
<td>1.55</td>
<td>1.41</td>
<td>Low</td>
<td>Low</td>
<td>Poor Waste Managers</td>
</tr>
</tbody>
</table>

Dividing the individuals into clusters as such is potentially useful, because the general characteristics of each of these groups can now be summarized and statistically analyzed to see if each group shares identifiable characteristics, which can potentially be used to inform waste management policy. In essence, this creates a generalized demographic profile of individuals in the population who are likely to engage in the generalized levels of recycling and composting detailed in Table 5.22. The summary demographic characteristics and their level of statistical significance can be seen in Table 5.23.

The demographic statistics were tested for significance through a “chi-square” analysis. A chi-square analysis can be used in a number of ways, but for this portion of the analysis, it was used to determine if the proportion of individuals from each cluster

\[^{37}\text{One data point was thrown out because it did not have a composting value.}\]
differed significantly for the given demographic characteristics. For example, the proportion of respondents of each cluster falling into each of the three age groups differs. Cluster 3 (PWM) has a high proportion of 18-29 year-olds (48.4%), while Clusters 1 (ARC) and 2 (AR) are mostly comprised of 30-49 year-olds (62.5% and 49.0%, respectively). This is descriptive, but without the chi-square test, nothing can be inferred regarding the population. The chi-square test, however, determined that the proportion of respondents falling into each age group differed significantly, with a p-value of 0.0127, meaning that there is a less than 2% chance that the proportions are in fact equal. There is thus high confidence that the groups are made up of proportionately different age groups.
### Table 5.23 Demographic Characteristics of Waste Management Clusters

<table>
<thead>
<tr>
<th></th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
<th>Chi²</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Avid Recyclers &amp; Composters</strong></td>
<td>Avid Recyclers</td>
<td>Poor Waste Managers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>5</td>
<td>29</td>
<td>31</td>
<td>12.7</td>
<td>0.0127</td>
</tr>
<tr>
<td>30-49</td>
<td>20</td>
<td>50</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50+</td>
<td>7</td>
<td>23</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>female</td>
<td>16</td>
<td>61</td>
<td>34</td>
<td>1.3</td>
<td>0.5269</td>
</tr>
<tr>
<td>male</td>
<td>16</td>
<td>41</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bachelor's degree or higher</td>
<td>28</td>
<td>87.5%</td>
<td>87</td>
<td>85.3%</td>
<td>37</td>
</tr>
<tr>
<td>no bachelor's degree</td>
<td>4</td>
<td>12.5%</td>
<td>15</td>
<td>14.7%</td>
<td>27</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$35,000 or less</td>
<td>7</td>
<td>21.9%</td>
<td>20</td>
<td>19.6%</td>
<td>22</td>
</tr>
<tr>
<td>$35,001-$75,000</td>
<td>5</td>
<td>15.6%</td>
<td>29</td>
<td>28.4%</td>
<td>24</td>
</tr>
<tr>
<td>$75,001+</td>
<td>20</td>
<td>62.5%</td>
<td>53</td>
<td>52.0%</td>
<td>18</td>
</tr>
<tr>
<td><strong>Household Size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>15.6%</td>
<td>22</td>
<td>21.6%</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>56.3%</td>
<td>40</td>
<td>39.2%</td>
<td>32</td>
</tr>
<tr>
<td>3+</td>
<td>9</td>
<td>28.1%</td>
<td>40</td>
<td>39.2%</td>
<td>17</td>
</tr>
<tr>
<td><strong>Homeowner</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>own</td>
<td>23</td>
<td>71.9%</td>
<td>67</td>
<td>65.7%</td>
<td>22</td>
</tr>
<tr>
<td>rent</td>
<td>9</td>
<td>28.1%</td>
<td>35</td>
<td>34.3%</td>
<td>42</td>
</tr>
<tr>
<td><strong>Residence Type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>apartment</td>
<td>7</td>
<td>21.9%</td>
<td>13</td>
<td>12.8%</td>
<td>21</td>
</tr>
<tr>
<td>detached</td>
<td>20</td>
<td>62.5%</td>
<td>59</td>
<td>57.8%</td>
<td>31</td>
</tr>
<tr>
<td>other</td>
<td>5</td>
<td>15.6%</td>
<td>30</td>
<td>29.4%</td>
<td>12</td>
</tr>
<tr>
<td><strong>Political Persuasion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Democrat</td>
<td>21</td>
<td>65.6%</td>
<td>70</td>
<td>68.6%</td>
<td>25</td>
</tr>
<tr>
<td>Independent</td>
<td>7</td>
<td>21.9%</td>
<td>13</td>
<td>12.8%</td>
<td>13</td>
</tr>
<tr>
<td>other</td>
<td>4</td>
<td>12.5%</td>
<td>19</td>
<td>18.6%</td>
<td>26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>32</td>
<td>16.1%</td>
<td>102</td>
<td>51.5%</td>
<td>64</td>
</tr>
</tbody>
</table>
Chi-square is a non-parametric test, so does not require a normal distribution or a specific pattern of variance between or among groups. However, if sample sizes are too small, false rejections of null hypotheses can result (McDonald 2009). As noted by Agresti and Finlay (2003) (and the Help Menu on jmp©), it is recommended that there are at least 5 samples in each cell of the chi-square matrix. In regards to this analysis, that means that there should be at least 5 people in each cluster with each characteristic. This condition was not met based on the data resolution of the survey instrument. The data in the age group, income level, education, residence type, and political persuasion categories had to be recombined to meet this criterion. However, I was able to retain logical categories while recoding, as can be seen in Table 5.23.

The cluster analysis resulted in some significant findings, but not for all of the variables. The proportion of respondents in the gender and household size categories were not significantly different, as evidenced by having a p-value greater than 0.05. The other six demographic variables were found to be significantly different between groups, with all but age and residence type having at least a 0.001 p-value. Some inferences can be drawn from these data. First, there appears to be a somewhat positive relationship between responsible waste management behavior and age. The ARC and AR groups had relatively equal proportion of 50+ year-olds, and the ARC group had the highest proportion of 30-49 year-olds (62.5%). A further indication of the relationship between age and responsible behavior is that the PWM cluster had the highest proportion of 18-29 year-olds. Overall, the 30-49 year-old age group most strongly defines good waste

\[^{38}\text{E.g. five or more 18-29-year olds in each cluster; five or more 30-49-year olds in each cluster; five or more Democrats, etc.}\]
management behavior, and 18-29 year-olds behavior. Education level exhibited a similar trend – ARCs and ARs had a much higher proportion of people with a minimum of a bachelor’s degree (greater than 85% each), while the PWM cluster had nearly 42% of its population with no bachelor’s degree. Income also appears to be positively correlated with responsible waste management behavior. The ARC group had the highest percentage of top earners (62.5%), followed by the ARs and PWMs. The PWM group had the highest proportion of the lowest income bracket, which was less than $35,000 per year, and the middle income bracket ($35,001 - $75,000). The Homeownership variable exhibited the same pattern as income level, with homeowners making up the highest proportion of the ARC group, followed by the AR and PWM groups. Over 65% of the PWM cluster was comprised of renters. Those living in detached homes were more likely to be in the ARC and AR cluster than those living in other types of dwellings, though they also comprised nearly half of the PWM cluster. Finally, Democrats dominated the ARC and AR groups, while “other” (Republican, Libertarian, Green, unaffiliated, and “don’t know”) comprised 40.6% of the PWC group.

Overall, the cluster analysis revealed that Avid Recyclers and Composters were likely to be middle-aged, educated, relatively high income, own their own (single family detached) home, and identify as Democrats. Avid Recyclers were likely to be middle-aged, educated, middle-to-high income, own their own home which is likely a single-family detached home, and identify themselves as Democrats. Finally, Poor Waste Managers were likely to be young, less-educated than the other groups, low-to-middle
income, live in rental housing, and not identify as Democrats. The implications of these results will be discussed in the next section.
Chapter 6 Discussion

6.1 Sampling and Study Design

The sampling method I employed ("call and collect") was a success, and has a number of benefits relative to other sampling methods. I was able to create a random sample of as many households as desired in as many census tracts as I desired to sample, with publicly available data. This process is largely automated, and could be used in any geographical area for which spatial data are available. The sampling procedure is extremely flexible, does not require the cumbersome process of searching voting registries, and avoids the problem unlisted numbers and cellular telephones present to phone surveys. Another benefit is that it leads directly to the creation of maps that can then be used to navigate to the selected locations. The primary drawback is that survey administration is very time-consuming – surveys were administered and/or collected for a few hours a day nearly every day for one month, and only 352 surveys were collected. The 75% overall response rate is very high for any survey-based research, but especially given the lengthy survey instrument that was used. However, the 56.5% usable response rate was lower than hoped. Most of the non-usable surveys were only missing a few items. Future research could address this problem either through the use of imputation methods (e.g. Shrive, Stuart, Quan & Ghali 2006), revisiting the households with missing data, or simply administering more surveys.
One important caveat to the randomness of the data is that apartments were undersampled. This research was meant to randomly select households, not buildings. Each apartment building had an equal chance to be selected as an individual household, yet there are multiple households within a single apartment building. Thus, individuals who live in apartments were less likely to be selected for the study than those living in single family homes, townhomes, or duplexes.

6.2 Descriptive Waste Management Behavior

The descriptive waste management behavior results offer a glimpse of the degree to which recycling and composting are undertaken in the sample, and preface the results of other analyses in the study. As expected, materials that are recyclable are reportedly recycled at a higher rate than non-recyclable materials and composting. Many studies have found that convenience plays an essential role in promoting PEB (e.g. Derkson & Gatrell 1993; Berger 1997; Jenkins et al. 2003), and having a curbside bin is much more convenient than storing and making one’s own compost. The relatively low frequencies with which non-recyclable items were put into recycling bins is positive, but these materials are apparently still placed in the bins at a higher than desirable rate.

It is encouraging that the mean recycling factor (the average of the average recycling scores\(^{39}\)) was 3.51 on a 5.0 scale, though the mean overall composting score was only 1.75. It is important to point out that such a high recycling rate may be misleading, because of response bias. There are three primary (and unavoidable in this context) problems with the method that was used to determine behavior. First, it was

\(^{39}\) Under most circumstances, averaging a set of averages is an invalid way to summarize data, but it is valid in this case because the average numbers that were averaged resulted from analysis of an identical number of numbers, thus each final average is proportional to the others.
made clear to the respondents from the outset that the survey was done in an attempt to ascertain waste management behavior in Denver. Recycling is largely seen as normative behavior (Barr & Gilg 2005), and this combined with knowing that the purpose of the research was to find out about recycling behavior could have influenced respondents to overstate their recycling rates. Secondly, self-selection bias could have played a role, in that people who do recycle may be more likely to respond to a survey asking about recycling behavior. The prize offering was meant to reduce the occurrence of this type of bias, but there is no way to know if it was effective or not. Only eight people who initially accepted the survey refused to take it after they read it, and fifty-six never returned the survey. Further, many people refused to take the survey after it was initially introduced. Unfortunately, data were not kept in terms of outright refusal rate. Finally, as Barr (2002) notes, self-reported behavior can be an unreliable metric. Answers can be exaggerated or underplayed (purposefully or otherwise), and aggregate estimation methods can be mistaken by the individual filling out the survey. For example, assessment of the difference between “sometimes” and “usually” engaging in a behavior is necessarily subjective. I used 5-item Likert scales in an effort to reduce the incidence of this problem, as they are less nuanced than 7-item scales, though this results in the loss of some data resolution. Overall, the most accurate way to measure behavior is to observe it first hand, but this was obviously impossible to do for this study.

Caveats aside, the recycling rate results are encouraging and speak to the potentially normative stature of recycling in the study area. However, the behavioral frequency results indicate that two of the items should be addressed by the city. First,
aerosol cans are recycled at a very low rate (2.19), with over 50% of the sample reported that they “never” recycled aerosol cans. This could be due to any number of factors, among them being that people tend to view aerosol cans as dangerous (they are in fact explosive if put under high pressure), and thus are hesitant to deposit them into recycling bins. It is also possible that because many aerosol-type cans contain spray paint, which is not recyclable, they are recycled at a lower rate. Finally, aerosols may not be used as much as other materials. The Likert scale description in the survey asked respondents to indicate “how often” they recycle the items. This could easily be interpreted in such a way that if an item, such as an aerosol can, is rarely used, it is thus “rarely” recycled, even if it is recycled every time it is used. This should be remedied in future studies by more clearly indicating the intent of the Likert items.

The second item of concern is plastic bags. Self-reported frequency of recycling plastic bags at home was 3.01, which is nearly as high as most of the recyclable items. Nearly half of the respondents indicated that they either “always” or “usually” recycle plastic bags at home. This is cause for concern, because according to Waste Management (n.d.){40}, plastic bags are detrimental to the operation of the recycling sorting machinery and cause delays in hand-sorting. It is not clear why plastic bags are placed in bins, though the fact that plastic bags can be recycled at many locations throughout the city (grocery stores, mostly), may be causing confusion. Future research could be undertaken to determine why aerosol cans are not being recycled, and why plastic bags are being placed in home recycling bins. Regardless of the reason(s) for the plastic bag and aerosol rates, it appears that both should be addressed. Note that plastic tubs were reported as

---

{40} Waste Management is one of the leading garbage/recycling haulers in the U.S.
being recycled at a somewhat elevated rate (2.22), but this is no longer of concern because the city now accepts them in the single-stream bins.

In terms of grass-cycling, the average score (3.12), which was slightly higher among those not living in apartments (3.17), and was nearly as high as the recycling score. The level of grass-cycling is encouraging because DR features it on their website along with other responsible waste management materials. It is not clear through the survey results why the rate of grass-cycling is relatively high, as the only other question asked regarding grass-cycling was designed to find out what prevents residents from grass-cycling. Thirty percent of the respondents that did not grass-cycle indicated that the reason they did not do it was because they had never heard of it, and 23% noted that they thought it would kill the grass, while 10% said they did not think that was important. The policy implications that can be gleaned from this information are that general awareness of the practice may be the most effective policy if DR desires to increase the incidence of grass-cycling in the city. Further, if this publicity can be combined with information disabusing people of the idea that it will kill the grass and it is not important, over 60% of the volume of reasons given for not grass-cycling could be addressed. Note that over half of the respondents reported getting their recycling information from the booklet that came with the large bin, so it may be advisable to include information regarding grass-cycling and composting with booklets that are provided with bins. For residents who already have booklets, a few alternative policies could be undertaken. First, a booklet could delivered to homes that already have recycling. However, this may not be very effective, because as the data show, not only
are respondents recycling at a relatively high rate, but the average recycling habit is quite strong, as measured by the SRHI. Recall that many of the constructs of the SRHI are related to the automaticity of the behavior, so providing recycling information regarding materials that are already strongly habitual may not be effective because people already know, largely without thinking, what materials and how to recycle. However, there are two possible remedies to this situation: First, if a new material or materials become allowable recyclables in the future, the booklet could be provided with this new information. Secondly, as the new composting program ramps up, information regarding grass-cycling should be included with the compost bin.

Overall, the sample indicated a strong willingness to pay for recycling and waste management services, as 84% of those asked if they would pay $1/month indicated they would be “likely” (15%) or “extremely likely” (68%\(^{41}\)) to do so, and 66% of those asked if they would pay $3 were “likely” (30%) or “extremely likely” (37%) to do so. The relative frequencies of these results are not surprising, as it is expected that as proposed costs increase, WTP will decrease, echoing results by Batley et al. (2000) and Palatnik et al. (2005). This is an encouraging result, especially in terms of recycling and trash removal. Charging only $1/month to everyone eligible for both trash and recycling services would result in the generation of over $2 million in revenue, which would be enough to cover the entire DR budget as of 2007 (Pitt 2007).

There was a strong interest in free and fee-based composting services in Denver. Sixty-two percent reported being either “likely” or “extremely likely” to use a free composting service and 67% and 48% would be willing to pay $1/month and $3/month,\(^{41}\) Some of the percentages provided may not add up properly due to rounding errors.
respectively, for home composting service. This is somewhat surprising in light of the fact that the sample reported rarely engaging in composting behavior and had very weak composting habits. The average overall score on the composting SRHI was only 1.89, compared to 3.57 on the recycling SRHI. In other words, recycling habit was nearly twice as strong as composting habit. These seemingly contradictory results show that people have the desire to compost, but may not believe they have the means or knowledge to do so. This is exactly what is indicated by the aggregated answers to the question that asked what prevents respondents from composting. In fact, the most frequent answers to this question were that people did not want to store kitchen wastes at home and that they do not know how to compost. The bins would solve both of these problems. Not surprisingly, as proposed composting cost rose, desire to participate dropped. However, WTP was relatively strong, though even the highest monthly charge in this study ($3) is less than one third the cost of the optional recycling service being offered by DR currently ($29/quarter) (City of Denver 2011a). The success of the composting pilot program in Denver appears to confirm these results. It would be very interesting to see if composting habits and behavior have increased in the city as a result of the new composting program. One would assume that the increasing visibility of the composting program would increase the general awareness of, and perhaps concrete knowledge regarding home composting.
6.3 The Behavioral Model

6.3.1 Variable Groupings in the Factor Analysis

The results of the factor analyses were instructive, and for the most part, expected. First of all, the behavioral items loaded exactly as would be expected. The varimax-rotated factors were loaded with descriptive, logically consistent groups. The eleven recyclable items grouped into the “Recycling Behavior” factor, the three non-recyclable items made up the “Errant Recycling” factor, the two composting items loaded into the “Composting Behavior” factor, and Grass-cycling comprised its own factor. The individual variables demonstrated very high internal consistency – with the exception of aerosol cans in the Recycling Behavior factor, which has a correlation coefficient of 0.54, all variables had at least a 0.76 factor loading within their respective components, and all Cronbach’s alpha values were above 0.7. These are important results, because they allow for a high level of confidence in the legitimacy of grouping the behavioral items into these factors. Illegitimate results can occur if a researcher groups variables without performing a factor analysis or if the factor analysis is done improperly.

Past studies have shown the NEP to be multidimensional (e.g. Barr 2002; Nooney et al. 2003), so it is not surprising prima facie that the NEP factor analysis resulted in three factors. Upon closer inspection, the factor loading was logical. Factor one can be considered “Pragmatic Environmentalism,” which consists of less controversial propositions that 1) the environment should be considered when decisions are made, 2) human development depends on proper use of natural resources, and 3) that nature can be harmed by human changes. Many of these assertions could conceivably be held by even
non-environmentalists, as they are practical. Evidence abounds for the negative impacts humans can have on nature, the need for natural resources, and environmental degradation caused by human decision-making. The second factor is termed “Deep Ecology” because it contains constructs that are border on valuing nature more than humans. Deep Ecology is a belief that nature has as much (if not more) inherent value than humans. The three items in Factor 2 indicate a relatively extreme view of the value of nature, such as proposing to halt all land development and that nature is just as valuable as human beings. Finally, Factor 3 is termed “Enviro-centrism” because it contains two items that center on (not) holding the environment as a central personal concern. The internal consistency of the factors was acceptable. It would be interesting to see if these results could be duplicated in further research in Denver or elsewhere, and to determine whether or not they are correlated with other forms of PEB.

The psychological variable factor analyses resulted in both predictable and surprising outcomes. It is important to note that only the psychological variables related to each behavior were factored together. For example, recycling SRHI and recycling convenience were not subjected to factor analysis with the composting variables. This stated, the same norm-related variables were used in both analyses. It is clear that recycling habit (RH) is unidimensional, and appears to be a reliable measure of RH. The Cronbach’s alpha was over 0.96 and only the 12 items of the SRHI scale loaded into the factor, so the construct has a very high internal consistency. This agrees with the findings of Verplanken & Orbell (2003), and the correlative strength indicates that the

---

42 This characterization of an “extreme” view should not be misconstrued as me having a negative view of deep ecological thought, only that this viewpoint is extreme relative to what can be considered more mainstream thought.
SRHI is a reliable measure of habit strength. The same can be said for the composting habit (CH), though one of the Perceived Convenience variables (“composting is easy”) loaded onto the SRHI factor. It is somewhat surprising that the ease of composting was found to load onto the same factor with all of the SRHI items, but upon further thought, it is logical. As noted by the creators of the SRHI (Verplanken & Orbell 2003) and others (e.g. Dahlstrand & Biel 1997), the main characteristic of a strong habit is the (near) automatic response to an external stimulus. Multiple items in the SRHI scale reflect this. If one has a well-established composting habit, it is implied that they are able to compost, and do so frequently (this is also addressed by the SRHI). If composting behavior is done frequently and almost without thinking, it would likely not be perceived as a difficult behavior, as doing something automatically implies that it is done with little effort. Note also that perceived ease of recycling loaded fairly heavily on the same factor as recycling habit, but it was more correlated with the Efficacy and Convenience factor. It appears that perceived convenience may be correlated with habit, and may be a useful subject for future research.

The norm acceptance and norm awareness variables each loaded together as expected for both recycling and composting, which is to be expected. However, all of the other psychological variables loaded into one factor for recycling and composting. This is a surprising result, because variables within this factor were designed to measure attitude, response efficacy, perceived convenience, and personal efficacy. This is a good example of why factor analysis is a useful statistical method, as it shows that these seemingly unrelated variables are in fact highly correlated. It is not clear why these
factors were so well correlated, as they followed similar question constructs used in studies that found them to load on separate factors (e.g. Barr 2002). It is possible that those that engage in specific levels of recycling and composting behavior share many of the same beliefs, attitudes, feelings of efficacy, and notions of convenience about the behaviors. It is also possible that the limited number of variables that I used to ascertain these constructs compromised the model’s ability to derive multiple factors. It would be instructive to undertake future research and see if similar results occur.

6.3.2 Regression Analysis and the Behavioral Models

The factor analysis reduced the number of input variables into each of the behavioral models from 35 to 14 for recycling and 34 to 13 for composting. Figure 6.1 and Figure 6.2 show the results (via a path diagram) that occurred after each set was run through the regression models with their respective behavior (recycling or composting) scores as the outcome. As noted in Chapter 5, the coefficients in these diagrams are called “beta weights,” otherwise known as normalized regression coefficients. They demonstrate the predictive power of the independent variables on the dependent variable. The purpose of performing a regression analysis is to attempt to demonstrate causality. But it is important to note that the complexity of human behavior is such that it is nearly impossible to say that any single factor or set of factors caused a behavior to occur. There are inevitably factors that have not been considered by the researcher, as evidenced by the error terms in each of the models. The relatively small error term in each of the models indicates that I can say with moderate confidence that the independent variables in the model are valid causal predictors of the behaviors. That
stated, the error term indicates that there are a number of intervening variables that are not present in the model, which render the model less than perfect. In general, increased predictor variables reduces the error term. Future research should include more variables if possible. The strongest implication of the models is the relative predictive strength of each variable. In other words, the path coefficients demonstrate which variables are more likely to lead to the given behavioral outcome, with higher coefficients being stronger predictors than lower ones.

These two behavioral models have many implications. First, it is readily apparent that many of the variables were not found to be significant influences on behavior. For the recycling model, none of the demographic variables were found to be statistically significant. This is a somewhat surprising result, as Barr *et al.* (2005) found age to be positively correlated with recycling behavior, though the beta value was only 0.07, so did not have a strong impact on recycling behavior. Other studies researched for this report found that demographics were correlated with recycling behavior (e.g. Steel 1995; Swami, Chamorro-Premuzic, Snelgar, & Furnham 2011), but others found no correlation (e.g. Ebreo *et al.* 1999). Age was the only demographic variable that had a significant impact on composting. Being over 40 years old was shown to be negatively correlated with composting behavior. This seemed to be a curious result, as I assumed that older people would be more likely to have a garden, but the sample data show that those under 40 (55% had a home garden) were more likely to have a garden than those older than 40 (35% had a home garden). This makes intuitive sense, as a person would seemingly be

---

43 Negative correlation coefficients are predictors that the behavior will not occur – more negative means less likely that the behavior will occur.
more likely to compost if they had a use for the compost. As it turns out, this also makes statistical sense, because having a home garden was the second biggest influence on composting behavior next to habit formation.

Figure 6.1 Recycling Behavioral Model

None of the NEP factors were found to be significant in the recycling model, which is a slightly unexpected result. Many studies have found that NEP is positively correlated with PEB in general (e.g. Steel 1996; Cordano et al. 2003) and recycling in particular (e.g. Barr & Gilg 2005). It is intuitive that possessing and environmental worldview would lead to PEB in general, including recycling. This result has a few possible implications. It is possible that environmental values are the norm for the
population studied. The descriptive results do indicate that this is likely the case for most of the NEP constructs, as the average answer to all of the NEP questions (with the exception of the two deep ecology questions) was at or above “agree,” (i.e. near or above a mean value of 4.0). If adherence to the NEP is normative, then level of agreement with NEP items would not be expected to differ among behavioral groups. Further research should be undertaken to ascertain the general level of environmental awareness in Denver, and if it is correlated with recycling and composting behavior. If similar results are borne, the policy implication would be that addressing larger environmental issues is not an effective way to increase waste management diversion rates.

An even more surprising result is that of the NEP factors, only Deep Ecology demonstrated a significant impact on composting, but it was negatively correlated with composting behavior. This is an exceedingly odd result, as it is clear that composting is not normative behavior for the population being studied. This is apparent from the low average recycling behavioral and habit scores. Yet, apparently those who express an extreme level of environmental belief are actually less likely to engage in composting behavior. It is likely that there are other mediating circumstances that prevent this group from composting, but one of the benefits of running a regression analysis is that it analyzes variables on their own merit, while holding other variables constant, which minimizes the chance of this occurring. However, the error term in the composting behavioral model is relatively high (0.62), so there is likely a variable or set of variables that mediate(s) the relationship between the Deep Ecology NEP and composting behavior. In addition, as Figure 5.2 indicates, scores on NEP item 3 – “Nature and the
environment have as much value as human beings” – was surprisingly high (4.09) given its extreme implication. This statement is the epitome of Deep Ecology, a viewpoint that is not held by mainstream American society. This item is included in the Deep Ecology NEP factor. Perhaps the item was misunderstood and over-reported, thus leading to the odd result relative to composting behavior. Future research may be needed to address this, and perhaps the item should be reworded in future studies.

The Efficacy, Convenience and Attitude factor demonstrated a moderate impact on both recycling and composting behavior, which is to be expected. These concepts have been shown to be correlated with recycling behavior (e.g. Barr & Gilg 2005) and composting behavior (e.g. Taylor & Todd 1995). Actual Convenience (having a large bin) and Concrete Knowledge were found to be positively correlated with recycling behavior, which is an expected result. Convenience and CK are almost universally recognized as important influences on PEB in general and recycling in particular. Having a garden can be viewed as a proxy for actual convenience in relation to composting, so it is not surprising that having a garden is positively correlated with composting.

In both models, habit is shown to have a very powerful predictive impact on behavior. In the recycling model, it is equally as powerful as the error term, and is only slightly smaller than the error term in the composting model. In both models, it was the strongest predictor of all discrete independent variables. This corroborates the results of studies of recycling (e.g. Knussen & Yule 2008) and PEB (e.g. Dahlstrand & Biel 1997). No studies to date have measured the impact of habit on composting. These findings have important implications for waste management policy in Denver. It appears that the
most effective way to increase behavior is to somehow attempt to influence the formation of habits. Dahlstrand and Biel (1997) propose a seven-step model of habit formation, and purport that many actions can be taken to exogenously cultivate desired habits buy intervening in any number of these steps. The seven steps can be seen in Table 6.1.

This is a logically-structured model, and offers many opportunities for DR to attempt to positively influence recycling and composting habit, and hence behavior. Though this study has shown that they are not direct influences on behavior, pro-environmental beliefs may serve to “prime” the formation of PEB habit. At any rate, it is very difficult for DR to greatly influence general environmental values, as in the modern information age, there are so many other environmental influences as to render any campaigns by DR lost in the environmental awareness “noise,” so to speak. Part of the Activation step is normative influence, which was found to be insignificant in terms of driving PEB in this study, but it could also possibly act as a priming step that may ultimately lead to habit formation and hence, behavior. However, it may be difficult to impact normative influences, though campaigns that tell people how much (more) their neighbors are recycling and/or composting may be effective. Steps three through six can readily be addressed by DR. Making alternatives evident and providing clear procedural instructions can be accomplished through awareness campaigns regarding the availability of recycling and composting and providing information on how to do it. This is corroborated by the respondents’ answers to the descriptive questions. Two of the top three reasons given for not composting at home are “I do not know how to compost” and “I never thought about it.” Both of these can be addressed through information and
awareness campaigns. The fourth most-frequently cited reason was “I have no use for it,” which could also possibly be addressed through information campaigns. Providing bins can overcome step 5 (testing the new behavior), and providing information regarding how many pounds of CO₂ or methane were saved, or other resources saved or money saved, may help residents get past step six, after which the habit should be formed.

Table 6.1 Stepwise Model of Behavioral Change Toward a Pro-Environmental Habit

<table>
<thead>
<tr>
<th>Impeding Factors</th>
<th>Substeps toward PEB habit</th>
<th>Promoting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly established, old habits</td>
<td>1) Activation</td>
<td>Priming of pro-environmental values</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perceptions of others' PEB</td>
</tr>
<tr>
<td></td>
<td>2) Attending present behavior</td>
<td>Specific information about present behavior and negative environmental consequences</td>
</tr>
<tr>
<td>Negative beliefs about alternative</td>
<td>3) Consider alternative solution</td>
<td>Evident, existing alternatives</td>
</tr>
<tr>
<td>Lack of specific knowledge</td>
<td>4) Planning new behavior</td>
<td>Clear procedural instructions</td>
</tr>
<tr>
<td>Physical obstructions</td>
<td>5) Testing the new behavior</td>
<td></td>
</tr>
<tr>
<td>Unexpected negative consequences</td>
<td>6) Evaluation of the new behavior</td>
<td>Positive feedback</td>
</tr>
<tr>
<td></td>
<td>7) Establishment of the new habit</td>
<td></td>
</tr>
</tbody>
</table>

Source: Dahlstrand and Biel (1997), p. 590

One final point regarding habit formation – as noted by Dahlstrand and Biel (1997) and Verplanken and Orbell (2003), habit is not necessarily characterized by frequency of behavior as traditionally thought. It is actually a (near) automatic response to a cue. For example, when approaching a road that must be crossed in the U.S., most people automatically look left, then right before the road is crossed. Most likely this is done without thinking, but is actually an automated response to the external stimulus of
crossing the street. Thus a habitual behavior is largely the result of an association with another factor. This relationship can be taken advantage of through structured information campaigns that attempt to associate a desired behavioral outcome with a given environmental cue. For example, leaflets could be given or emails sent to residents with simple pictures and words that convey the message “Making a fresh pot of coffee? Put the old grounds in your compost bin!” or other similar exhortations.

6.3.3 Comparison to Exeter Study

I could find no comprehensive contemporary study of waste management behavior in the literature, with the exception of the study by Stewart Barr (2002), which serves as the model for this research. Ideally, the results contained within this report should be compared with results from similar studies in other cities, preferably in the United States, in order to make regional comparisons. This would lend a strong spatial component and would contribute to the literature in Regional Geography in addition to the current focus on Environmental Perception and Behavioral Geography. This is an important suggestion for future research. Note that Barr gathered his data in 1999, and administered 983 surveys to randomly selected households using the “call and collect” method, receiving 673 completed surveys in return (a 69% response rate). The survey was 10 pages long, with self-reported behavior as the dependent variables. Barr does not indicate the number of questions that were on the survey instrument.

---

44 Recall that this study was similar in most ways to Barr’s study, including the use of the behavioral models, with the major exception that a) my study took place in a very different geographical context and b) I integrated the habit construct in addition to the NEP, situational variables and psychological variables.  
45 As I note in chapter 2, this study is inherently geographic in nature, but most specifically addresses issues pertinent to Environmental Perception and Behavioral Geography.
A full comparison may be undertaken at a future date, but due to the limited scope of this research, a few key components of the research will be compared. First, a comparison of the NEP average scores and factor loadings can be seen in Table 6.2 and Table 6.3, respectively. Recall that one of the primary goals of this research was to contribute to the overall body of research regarding NEP, including dimensionality.

### Table 6.2 Mean NEP Item Scores in Exeter and Denver Samples

<table>
<thead>
<tr>
<th>NEP Scale Item</th>
<th>Exeter</th>
<th>Denver</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>The environment is forgotten too often when decisions are made (NEP 1)</td>
<td>3.88</td>
<td>4.21</td>
<td>7.8%</td>
</tr>
<tr>
<td>If we over-use our natural resources, human development may be harmed in the future (NEP 2)</td>
<td>4.04</td>
<td>4.56</td>
<td>11.4%</td>
</tr>
<tr>
<td>Nature and the environment have as much value as human beings (NEP 3)</td>
<td>3.8</td>
<td>4.09</td>
<td>7.1%</td>
</tr>
<tr>
<td>Humans should not develop any more resources or land, in order to protect the natural environment (NEP 4)</td>
<td>3.21</td>
<td>3.02</td>
<td>-6.3%</td>
</tr>
<tr>
<td>Nature isn't harmed by human changes* (NEP 5)</td>
<td>4.14</td>
<td>4.6</td>
<td>10.0%</td>
</tr>
<tr>
<td>Human welfare should be our primary concern in the future* (NEP 6)</td>
<td>2.92</td>
<td>2.81</td>
<td>-3.9%</td>
</tr>
<tr>
<td>The environment is of little concern to me* (NEP 7)</td>
<td>4.12</td>
<td>4.61</td>
<td>10.6%</td>
</tr>
<tr>
<td>Getting through daily life and surviving is what concerns me the most, not the environment* (NEP 8)</td>
<td>3.45</td>
<td>3.86</td>
<td>10.6%</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>673</td>
<td>199</td>
<td></td>
</tr>
</tbody>
</table>

*Reverse coded

There are a few results outlined in Table 6.2 worth noting. First, it is clear that the mean scores of the NEP items are relatively similar between the two samples, with no single answer differing more than 11.4%. However, with the exception of items 4 and 6, the Denver sample had higher average scores than the Exeter sample. This indicates that the sample (not the population\(^47\)) in Denver had more robust environmental values, at least according to the NEP construct used in these studies. It would be instructive to research why these differences exist, and more importantly, attempt to make inferences to

\(^{46}\) Source: Barr 2002, p. 99

\(^{47}\) These are descriptive statistics, so no inferences can be made to the population.
the populations in both studies to determine if statistically significant environmental value differences exist between the two cities. Second, it appears that these values are largely normative behavior in the samples, as all scores were above average with the exception of item number 6, though item 4 had just above average scores. These results are not very surprising, given the nature of the questions. NEP 4 asks the level of agreement with the notion that no more land or resources should be developed in order to protect the environment. This is a relatively extreme viewpoint that even strong environmentalists are likely to disagree with to an extent. Resources and land can be developed with minimal environmental damage, so disagreeing with this statement does not render one “anti-environment.” NEP 6 (reverse coded) states that “human welfare should be our primary concern in the future.” This is less extreme than NEP 4, but agreeing with this statement can be seen as morally correct, albeit in an anthropocentric sense.

Finally, it is worth noting that the Deep Ecology item (NEP 3) that had what I thought was a surprisingly high score (4.09) in Denver given its relatively extreme nature (“Nature and the environment have as much value as human beings”), had a similarly high score (3.80) in Exeter. This is a surprising result. An interesting topic for future research is to look more in-depth into this construct to see if the population(s) at large has an ecocentric worldview, as indicated by these descriptive results.
Table 6.3 NEP Factor Loadings in Exeter and Denver

<table>
<thead>
<tr>
<th>NEP Item</th>
<th>Denver</th>
<th>Exeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>The environment is forgotten too often when decisions are made (NEP 1)</td>
<td>0.812</td>
<td>0.643</td>
</tr>
<tr>
<td>If we over-use our natural resources, human development may be harmed in</td>
<td>0.751</td>
<td>0.690</td>
</tr>
<tr>
<td>the future (NEP 2)</td>
<td></td>
<td>0.329</td>
</tr>
<tr>
<td>Nature isn’t harmed by human changes* (NEP 5)</td>
<td>0.731</td>
<td>0.821</td>
</tr>
<tr>
<td>Nature and the environment have as much value as human beings (NEP 3)</td>
<td>0.499</td>
<td>0.593</td>
</tr>
<tr>
<td>Humans should not develop any more resources or land, in order to protect</td>
<td>0.356</td>
<td>0.672</td>
</tr>
<tr>
<td>the natural environment (NEP 4)</td>
<td></td>
<td>0.009</td>
</tr>
<tr>
<td>Human welfare should be our primary concern in the future* (NEP 6)</td>
<td>-0.166</td>
<td>0.786</td>
</tr>
<tr>
<td>The environment is of little concern to me* (NEP 7)</td>
<td>0.299</td>
<td>0.809</td>
</tr>
<tr>
<td>Getting through daily life and surviving is what concerns me the most,</td>
<td>0.062</td>
<td>0.796</td>
</tr>
<tr>
<td>not the environment* (NEP 8)</td>
<td></td>
<td>0.464</td>
</tr>
</tbody>
</table>

Table 6.3 shows a comparison of the factor loadings for the NEP items in the two studies. Interestingly, Factors 1 and 2 are nearly identical in both studies. The only difference in Factor 1, which I termed “Pragmatic Environmentalism” is that in the Exeter study, NEP 7 (“The environment is of little concern to me”) loads strongly onto the factor. Factor 2 only differs in the Exeter study by virtue of NEP 3 not loading onto it, whereas it does load weakly onto Factor 2 in Denver. It could be argued that due to the relatively weak loading of NEP 3 in the Denver study, the Factor 2s are identical in both studies. These are significant results, and they add power to the notion that certain NEP items (NEP 1, 2, and 5; NEP 4 and 6) are likely unidimensional. Conversely, the fact that Barr’s study found two factors and my study found three factors, as well as the

---

48 Source: Barr 2002, p. 114
slight differences in similar factors, indicates the importance of running a factor analysis when utilizing NEP items in research. It would be instructive to do a wider-scale survey of just the NEP items in both cities to see if similar results occurred, and if any implications can be made about each city’s environmental value systems.

Barr also derived a behavioral model of recycling (but not composting) using regression analysis and ultimately beta weights. It is clear from Table 6.4 that the Exeter study found significantly more independent variables that impacted recycling behavior. It is important to note that four of these variables were not found to have direct impacts on recycling behavior, but predicted intention to act, which was a strong predictor of behavior. Barr calculated the indirect effect of these variables, as indicated by the asterisk in Table 6.4.

### Table 6.4 Recycling Beta Weights for Exeter and Denver Studies

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Beta Weight</th>
<th>Exeter</th>
<th>Denver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willingness/intent</td>
<td>0.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has a curbside bin</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convenience/effort</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local waste knowledge (concrete knowledge)</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness of norm</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active concern*</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>House type*</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge sources*</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Importance of nature</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceptance of norm to recycle</td>
<td>0.009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static recycling provision*</td>
<td>-0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habit</td>
<td></td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Concrete knowledge</td>
<td></td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Efficacy, convenience and attitude</td>
<td></td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Actual convenience (having a large bin)</td>
<td></td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Error term</td>
<td>0.46</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td></td>
<td>0.79</td>
<td>0.82</td>
</tr>
</tbody>
</table>

*Indirect effect, mediated by intention to recycle

This comparison has a few important implications. First, though Barr integrated three times as many variables into his regression equation, his variables explained less of the variance than in the Denver model. These $r^2$ values are similar enough to be essentially the same, and it is surprising that the model with significantly fewer

---

49 Source: Barr 2002, p. 122
independent variables was as powerful. This is likely due to the very high beta weight for the habit construct. A very important result is that actual convenience (having a curbside bin in Exeter and a large bin in Denver) was a strong predictor in both models. Concrete knowledge is a strong predictor in both models as well. Convenience has been cited in numerous studies (e.g. Berger 1997; Jenkins et al. 2003) as having a positive correlation with recycling behavior. This is an intuitive result. Concrete knowledge, in this case operationalized as knowledge of local waste rules, is also a logical predictor of recycling behavior. It is clear that knowledge of how to recycle will be associated with behavior, though the causal relationship is questionable.

6.3.4 Characteristics of (Ir)responsible Waste Managers

The cluster analysis revealed some details regarding generalized characteristics of individuals who engaged in relative levels of waste management activity that cannot be found elsewhere in this study. The cluster analysis resulted in three groups ("clusters") of respondents with summarized demographic characteristic, and so I am able to provide a general portrait of what an Avid Recycler and Composter (ARC) (high self-reported recycling and composting), an Avid Recycler (AR) (low level of composting) and a Poor Waste Manager (PWM) (low levels of both behaviors) is. Generally speaking, an ARC is likely to be middle-aged, educated, have a relatively high income, own their own single family detached home, and identify themselves as a Democrat. An AR is likely to be middle-aged, educated, middle-to-high income, own their own home which is likely a single-family detached home, and identify themselves as a Democrat. Note that the only significant difference between the first two groups is that the ARC is slightly more likely
to be middle-aged, less likely to be female, and likely to have a slightly higher income. The PWM were likely to be young, less-educated than the other groups, low-to-middle income, live in rental housing, and not identify as Democrats.

These findings have policy implications. As pointed out by Barr (2005), the most highly committed PEB groups cannot improve their behavior much more, and thus waste managers are not best served by focusing on changing this group’s behavior. Barr believes that PWMs are probably not likely to change their behavior, so it is probably not worth the time and effort to try to influence them. I agree with the first belief – the ARCs have a high level of commitment to recycling and composting behavior, and are likely to continue to do so. Also, they are the smallest group, so there is less to be gained. The primary focus of composting campaigns should be the AR group, as they are likely the most amenable to a PEB-based change such as composting, but also are the largest group, comprising over 50% of the sample. Recycling campaigns should be focused on the third group, since they are the only ones with low recycling rates. Policymakers can take into account the results of the cluster and regression analyses to guide action. For example, it may be beneficial to solicit relatively well-to-do home owners (not renters) during composting campaigns. The campaign could utilize suggestions from the previous section, such as providing specific information regarding composting procedures and/or fostering associations between specific situations and desired behavior.

6.3.5 Neighborhood Comparison

The following six figures provide a graphical description of the demographic variables that were found to be statistically significant in the cluster analysis.
Figure 6.3 Age Distribution of Denver Neighborhoods and Clusters

Figure 6.4 Income Distribution of Denver Neighborhoods and Clusters

Figure 6.5 Housing Type Distribution of Denver Neighborhoods and Clusters
Figure 6.6 Political Persuasion Distribution of Denver Neighborhoods and Clusters

Figure 6.7 Educational Attainment Distribution of Denver Neighborhoods and Clusters
There are a couple of interesting implications of these results. First, it is clear that there is not a great amount of variation in self-reported recycling and composting rates between the neighborhoods, although the samples from Capitol Hill, City Park West, Cory-Merril, and Whittier appear to recycle at a slightly lower rate than the others sampled\textsuperscript{50}. For these four neighborhoods, mean recycling scores were approximately 3.0, which means that items were overall “sometimes” recycled. This number is somewhat deceiving, because as indicated in Figure 5.1, aerosol cans were recycled at such a low rate (overall mean of 2.19) that recycling score means are artificially low. The mean composting scores were even less variable than the recycling scores, and were all below 2.0 with the exception of City Park and Whittier.

These figures also demonstrate that the Avid Recyclers and Composters and Poor Waste Managers (PWM) appear to be outlier groups, and may not be descriptive of any of the neighborhoods. None of the neighborhoods appear to have similar recycling and composting scores to either of these two clusters, but further analysis helps to clarify this.

\textsuperscript{50} Note that these are descriptive statistics, and make no inferences to the larger populations.
Close inspection of the cluster analysis results (Table 5.23), in conjunction with close inspection of Tables 6.3 – 6.8 help to assess the predictive capability of the cluster analysis. It is clear that education level, homeownership status, and political persuasion are the most egregiously different characteristics of the PWM relative to the other two clusters. Table 6.5 offers a comparison of the frequency of these variables in the neighborhoods and the clusters.

**Table 6.5 Comparison of Key Cluster Variables and Neighborhood Demographics**

<table>
<thead>
<tr>
<th></th>
<th>Education</th>
<th>Homeowner</th>
<th>Political Persuasion</th>
<th>Behavior</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Bach. Degree+</td>
<td>No Bach. Degree</td>
<td>Own</td>
<td>Rent</td>
<td>Dem</td>
</tr>
<tr>
<td><strong>Neighborhoods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congress Park</td>
<td>20</td>
<td>85%</td>
<td>15%</td>
<td>75%</td>
<td>25%</td>
<td>70%</td>
</tr>
<tr>
<td>Capitol Hill</td>
<td>19</td>
<td>63%</td>
<td>37%</td>
<td>37%</td>
<td>63%</td>
<td>47%</td>
</tr>
<tr>
<td>Cheesman Park</td>
<td>32</td>
<td>84%</td>
<td>16%</td>
<td>59%</td>
<td>41%</td>
<td>63%</td>
</tr>
<tr>
<td>Cory-Merrill</td>
<td>18</td>
<td>89%</td>
<td>11%</td>
<td>67%</td>
<td>33%</td>
<td>56%</td>
</tr>
<tr>
<td>City Park West</td>
<td>18</td>
<td>78%</td>
<td>22%</td>
<td>50%</td>
<td>50%</td>
<td>56%</td>
</tr>
<tr>
<td>City Park</td>
<td>23</td>
<td>78%</td>
<td>22%</td>
<td>48%</td>
<td>52%</td>
<td>35%</td>
</tr>
<tr>
<td>Speer</td>
<td>23</td>
<td>70%</td>
<td>30%</td>
<td>52%</td>
<td>48%</td>
<td>65%</td>
</tr>
<tr>
<td>Whittier</td>
<td>19</td>
<td>53%</td>
<td>47%</td>
<td>68%</td>
<td>32%</td>
<td>63%</td>
</tr>
<tr>
<td>Washington Park West</td>
<td>27</td>
<td>85%</td>
<td>15%</td>
<td>52%</td>
<td>48%</td>
<td>67%</td>
</tr>
<tr>
<td><strong>Clusters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avid Recyclers and Composters</td>
<td>32</td>
<td>88%</td>
<td>13%</td>
<td>72%</td>
<td>28%</td>
<td>66%</td>
</tr>
<tr>
<td>Avid Recyclers</td>
<td>102</td>
<td>85%</td>
<td>15%</td>
<td>66%</td>
<td>34%</td>
<td>69%</td>
</tr>
<tr>
<td>Poor Waste Managers</td>
<td>64</td>
<td>58%</td>
<td>42%</td>
<td>34%</td>
<td>66%</td>
<td>39%</td>
</tr>
</tbody>
</table>

This table is somewhat supportive of the predictive capability of the cluster analysis. The highlighted cells in the “Neighborhoods” section indicate if a

---

51 The Avid Recyclers and Composters, and the Avid Recyclers are in fact very similar demographically.
neighborhood has a similar demographic characteristic as the PWM cluster. Given the recycling and composting score comparisons between the clusters, one would expect that the neighborhoods that match up most closely to the PWM would have a relatively low recycling score, because a low recycling score is the only thing that truly distinguishes the PWM from the other clusters. The results are mixed. The neighborhood that is most demographically similar to the PWM is Capitol Hill, and Capitol Hill has the lowest recycling score. However, City Park is similar to PWM, yet is tied for second-highest recycling score. Further, City Park West has a very low recycling score, yet is demographically quite different than PWM. These results indicate the need for further research, and ideally a larger sample size within each neighborhood, but indicate that the cluster analysis does have some merit.
Chapter 7 Conclusion

Waste management behavior has important energy, environmental, economic and equity impacts. In the United States alone, nearly 132 million tons of municipal solid waste were deposited in landfills in 2009, much of which was recoverable material (EPA 2010). Landfilling at such a high rate (over 55%) costs money, unnecessarily creates greenhouse gas pollution, and represents a severe waste of valuable and increasingly limited natural resources. Much of this waste can be diverted at the household level through recycling and composting, but this diversion method requires buy-in from individuals. In other words, household waste management is a behavioral process. This presents a number of difficulties for those (policymakers, etc.) who wish to increase the incidence of waste diversion at the household level, for the causes of specific human behaviors can be influenced by many variables on multiple temporal, geographical, and even psychological (id to superego) scales. Models and behavioral correlates are frequently used in attempts to determine factors that lead to certain behaviors, which are then used as the basis for interventions that are meant to engender desired behavioral outcomes.

This research was undertaken in an attempt to describe recycling and composting behavior in select areas of the City and County of Denver and determine predictors of these behaviors, with the overarching goals of informing waste management policy and contributing to the overall body of research in this field. The results of this study have
achieved all of these goals to varying degrees. In terms of the first overarching goal, the following are general policy recommendations based on the results of this study:

- Aerosol cans were recycled at a very low rate, and plastic bags were reportedly frequently placed in home recycling bins. It appears that though overall recycling rates are high, DR would be well-served to remind recyclers that aerosol cans are recyclable, and plastic bags not. Plastic bags are particularly important to manage because they can clog sorting machinery and slow down hand-sorting.

- Grass-cycling was common among the sample, but the top two reasons for not grass-cycling are that respondents thought it would kill the grass and that it was not “important.” Grass-cycling information campaigns should prominently highlight that not only will it not kill the grass, but it will help it grow. This information is on the DR website, but perhaps it could be more prominent. Information campaigns should continue to focus on the importance, from personal to global scales, of grass-cycling.

- Booklets that came with bins were the primary means of gathering recycling information. It is recommended that booklets that detail composting and grass-cycling should be provided when possible.

- DR should entertain the possibility of charging for recycling and waste removal services. Nearly all respondents would be willing to pay $12/year for waste management services, which would provide upwards of $2 million in revenue, minus the additional overhead of administering the payment system.
• Habit strength was the most important predictor of recycling and composting behavior, so DR would be well-served to focus on ways to influence recycling and composting habit formation. Dahlstrand and Biel’s (1997) habit formation model would be very useful in this regard. As noted by Verplanken and Orbell (2003) and others, habit is an automatic response to an external stimulus. Perhaps a campaign promoting cueing would be helpful, for example by distributing marketing materials or advertisements stating, “Making a pot of coffee? Put the grounds and filter in the compost bin!”

• It appears that holding environmental values does not influence behavior, but climate change was cited as the most important motivation for responsible waste management. Climate change was cited with greater frequency than job creation and budgetary concerns. Perhaps stressing the climate-related benefits would be useful, though it is important to note that this survey took place in 2007 prior to the recession, thus new data should be gathered before informational campaigns are undertaken.

• Having a garden was a relatively strong predictor of composting behavior, thus DR may be well-served to encourage gardening, perhaps teaming up with Denver Urban Gardens to promote home and community gardening by residents.

• Two of the top three reasons given for not composting at home are “I do not know how to compost” and “I never thought about it.” Both of these can be addressed through information and awareness campaigns.
The sampling method was very effective. Anyone with a cursory knowledge of Geographic Information Systems could use the method described in Chapter 4 to select a random sample of any size using any geographic constraints, whether a stratified random sample of neighborhoods or other sections of the city, or a random sample of the whole city. In addition, the sampling method results in the production of a map that can then be used to administer surveys. The data used were free and publicly available, thus this method could be used in any geographic area in the world if data layers are available.

This study also contributes to the wider body of research on correlates of waste management behavior. It is the first piece of research to analyze the impact of habit strength on domestic composting. Habit was found to be the strongest influence on self-reported composting, and was more important than any of the other variables, which is a significant outcome. Those studying composting behavior have ignored this line of research – it is recommended that it be pursued further. Having a garden, perceived convenience, attitude, and response and personal efficacy were all important predictors of composting behavior as well. Similar to composting, recycling habit strength was found to be the most impactful variable relative to recycling behavior, followed by concrete knowledge; then perceived convenience, attitude, and response and personal efficacy; and actual convenience. These results are similar to the ones realized by Barr (2002) in a very similar study done in Exeter, England, which lend weight to the assertion that these variables are important predictors of recycling and composting. Note that Barr did not include habit in his models, which renders this study unique by virtue of its use of variables.
The results regarding the dimensionality of the modified New Ecological Paradigm scale were instructive, because the NEP was found to be made of three constructs, all three of which were intuitive (Pragmatic Environmentalism, Deep Ecology, and Enviro-centrism). These results contradict Barr (2002), who used the same NEP scale and found only two factors. The NEP variables loaded similarly in both studies, but not the same. This indicates that 1) future research is needed to study the dimensionality and loading of this NEP scale, 2) it is important to undertake factor analysis when using the NEP, and 3) perhaps NEP dimensionality vary according to geographic location.

Many possible avenues of future research can be undertaken based on the results of this study.

- This analysis can be viewed as a “snapshot in time” of self-reported recycling and composting behaviors in the neighborhoods studied. It would be instructive to perform a similar analysis in the same neighborhoods currently, in an attempt to discern if propensity to recycle has changed, and if so, why. Such a study may be instructive in many other ways, for example, to determine if environmental worldview has changed, if peer influence over recycling has changed, and if any of the studied variables have changed, and/or if their impact on behavior has changed.

- It would also be instructive to see if the optional curbside composting program currently being offered in Denver has altered self-reported composting rates, and made composting a more normative behavior. It is presumed that making such a
service is available would result in the composting rates increasing and the awareness of compost increasing, but perhaps only among certain segments of the population.

- Habit was found to be a strong influence on composting behavior. This is the first piece of research to study the impact of habit on composting, and the strong results indicate that this relationship should be further investigated, particularly in terms of habit intervention.

- The NEP item that expresses a Deep Ecology essential construct ("Nature and the environment have as much value as human beings") had a very high average score in this study (4.09 out of 5), and Barr’s 2002 study (3.8). This is a relatively extreme viewpoint. I am curious if this belief is indeed held by most people, either in general or in these neighborhoods, or if the question is confusing or otherwise being misinterpreted, and should be reworded.

- The same or similar study should be undertaken in other cities in the United States and elsewhere. The only published study to date that is similar is Barr’s 2002 study referred to above. Researching other cities would allow for regional comparison, and would (hopefully) strengthen the results.

- In a similar vein, if robust inter-neighborhood comparisons within Denver are to be made, more samples need to be taken. This could provide insight into ways to cater messaging and policies by neighborhood.

- Finally, this study could be used as a model for research to include more of, if not the entire City and County of Denver. Such research could be catered to the goals
and resources of whoever undertakes the study. If DR leads the research, they could use this study as a model, and choose which variables they would like to include based on their goals.

It is hoped that this research will be found useful by the City and County of Denver in regards to its waste management policies. In the least, it provides a snapshot of many factors related to recycling and composting in certain areas of the city, and can be used to inform policy and assist in the formation of future avenues of policy research. This is the first study of its kind in Denver - it will hopefully contribute to increasingly responsible waste management in the city and beyond.
Bibliography


Appendices

Appendix A

Select Natural Resource Management Benefits of Recycling

**Water Savings**
- Recycling one ton of paper saves 7000 gallons of water (a 58% savings), and creates 35% less water pollution (EPA)
- The recycling of Aluminum creates 97% less water pollution (Blatt 2005)
- Steel recycling uses 40% less water and produces 50% less water pollution (Blatt 2005)
- Glass recycling uses 50% less water (Blatt 2005)
- Reusing any of these products (as opposed to recycling or disposing) saves nearly 100% water and water pollution

**Energy Savings**
- Recycling aluminum uses 95% less energy; recycling one aluminum can saves the equivalent of 6oz. of gas (Blatt 2005)
- Each ton of recycled aluminum saves approximately 1 ton of petroleum products (Blatt 2005) – this equates to over 2 million tons of petroleum products thrown out in 2005 (EPA)
- Recycled glass saves 50% energy; recycling of one glass container saves enough energy to light a 100-watt light bulb for 4 hours; therefore, the equivalent of 32 million hours of light were thrown away last year (EPA)
- Recycling paper saves 23 – 74% energy; the paper industry is the largest single user of fuel oil in the country (Blatt 2005)
Raw Material and Aesthetics

- Recycling 1 ton of paper saves approximately 17 adult trees – the equivalent of over 71 million trees were thrown out in 2005 (EPA)
- Each ton of recycled paper saves 60 lbs of air pollution (~ 1.25 million tons of air pollution in 2005) (Center for Ecological Technology 2007); recycling paper results in 35% less water pollution (Blatt 2005)
- 1 ton of recycled aluminum saves 4 tons of aluminum ore; recycling aluminum causes 95% less air pollution and 97% less water pollution (Blatt 2005)
- Nearly one ton of resources are saved by recycling 1 ton of glass – over 1300 pounds of sand, 433 pounds of limestone, 151 pounds of feldspar; recycled glass produces 80% less mining wastes and 20% less air pollution (Blatt 2005)

Appendix B

Acceptable materials for curbside collection in Denver prior to June 2005

- newspapers (including inserts and ads)
- plastic bottles
- glass bottles and jars
- aluminum and steel cans
- aluminum foil and pie tins
- empty aerosol cans

Appendix C

Additional material accepted as of June 2005

- mixed office paper
- junk mail
- magazines and catalogs
- paperboard (cereal boxes, tissue boxes, etc)
- phone books
- brown paper bags,
- corrugated cardboard

149
Appendix D
Questionnaire given to all respondents

The following survey is being performed to obtain information about recycling and composting behavior in Denver. Participation is voluntary, and you may refuse to answer any question that you do not feel comfortable answering. You must be at least 18 years of age to participate.

The City and County of Denver did not provide any names or addresses for this study. It is being performed by an independent researcher.

However, information from this study may potentially be used by the City to improve, add, or otherwise alter these services. Please answer all questions honestly.

As you will see below, completing a survey will enter you into a drawing to win a $50 cash prize. The survey will take about 10 - 15 minutes to complete. Please answer as honestly as possible. It is not necessary to fill out all answers to be entered into the drawing.

All answers are anonymous, and will not be shared with anyone. No information, aside from the information you provide, is being used.

Thank you very much for your participation!
If you have any questions or concerns about this study, or you would like to see the results, please contact me (Dan Kasper) at recycling.survey@gmail.com or (303)756-0386 (email preferred). You may also contact my supervisor, Matthew Taylor, PhD, at the University of Denver at mtaylor7@du.edu, or (303)871-2656.

Thank you again for participating in the survey!!

This study was approved by the University of Denver’s Institutional Review Board for the Protection of Human Subjects in Research on June 4, 2007. If you have any concerns or complaints about how you were treated during this study, please contact Dennis Witmer, Chair, Institutional Review Board for the Protection of Human Subjects (303)871-2431, or Sylk Sotto-Santiago, Office of Sponsored Programs (303)871-4052.

You may keep this page for your records
To thank you for participating in this survey, I will draw 3 random surveys, and the winners will each receive a $50.

I will need contact information in the event your entry is drawn. The information will only be used to contact you if your entry is drawn. All information is strictly confidential, and will not be used for any other purpose. If you do not win, your contact information will be discarded. Good luck!

☐ Please enter me in the drawing.

Name (first name will suffice) ____________________
Phone number, email address, or mailing address
_________________________________________
_________________________________________

☐ I do not wish to be entered into the drawing.

Thank you!
Please have the person/persons who most often takes care of the household waste disposal answer the following questions. This person must be over 18 years of age. Some of the questions may appear to be similar, but they do address somewhat different issues. Please read each question carefully by circling the number on the 5-point scale that corresponds to your answer.

For example, if it asks how often you throw away old furniture, and you always do, you would circle 5:

1: never    2: rarely    3: sometimes    4: usually    5: always

However, if you almost never throw it away, you would circle 2:

1: never    2: rarely    3: sometimes    4: usually    5: always

If you throw it away only about half of the time, you would circle 3:

1: never    2: rarely    3: sometimes    4: usually    5: always

When filling in answers, please remember:
- circle only one answer per question
- answer all questions

This survey should take less than 20 minutes to fill out. Please answer as honestly as you can. Thank you again for participating!
All information is strictly confidential, and no identifying information will be shared with anyone. All scores will be averaged with scores of other people, so individual data will remain anonymous.

**Important:** Recycling only includes items you put into the recycling bin, not items you reuse for a different purpose.

Section 1. Recycling and Composting Behavior

1. For each of the following statements, indicate how often you actually perform the following activities at your residence. Please circle only one answer per item.

   a. Recycle glass bottles
      : 1 : 2 : 3 : 4 : 5 :
      never rarely sometimes usually always

   b. Recycle newspaper
      : 1 : 2 : 3 : 4 : 5 :
      never rarely sometimes usually always

   c. Recycle plastic bags at home (grocery, etc.)
      : 1 : 2 : 3 : 4 : 5 :
      never rarely sometimes usually always

   d. Recycle aluminum cans (soda, beer, etc.)
      : 1 : 2 : 3 : 4 : 5 :
      never rarely sometimes usually always

   e. Recycle steel cans (vegetables, soup, etc.)
      : 1 : 2 : 3 : 4 : 5 :
      never rarely sometimes usually always

   f. Recycle corrugated cardboard (pizza boxes, shipping boxes, etc.)
      : 1 : 2 : 3 : 4 : 5 :
      never rarely sometimes usually always
g. Recycle paper board (cereal boxes, cracker boxes, etc.)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

h. Recycle mixed office paper (junk mail, paper, etc.)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

i. Recycle magazines and catalogs

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

j. Recycle phone books

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

k. Recycle aerosol cans

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

l. Recycle plastic bottles (soda, water, etc.)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

m. Recycle plastic packaging (pretzel or chip bags, food packaging, etc.)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

n. Recycle plastic tubs (yogurt, butter tubs, etc.)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

o. Compost kitchen waste

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>
p. Compost yard waste

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
</tr>
</tbody>
</table>

q. Leave grass clippings in yard by not using a bagging mower (allowing clippings to be spread over lawn by the mower)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>usually</td>
<td>always</td>
<td>I don’t have a lawn</td>
</tr>
</tbody>
</table>

2. Is composting an important issue to you?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>unimportant</td>
<td>of little</td>
<td>moderately</td>
<td>important</td>
<td>very importance</td>
</tr>
</tbody>
</table>

3. Is recycling an important issue to you?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>unimportant</td>
<td>of little</td>
<td>moderately</td>
<td>important</td>
<td>very important</td>
</tr>
</tbody>
</table>

4. If Denver offered free compost pick up, how likely would you be to use the service?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>extremely</td>
<td>somewhat</td>
<td>average</td>
<td>somewhat</td>
<td>extremely unlikely</td>
</tr>
</tbody>
</table>

5. If recycling service was free, but you paid more the more trash you threw away, how likely would you be to recycle?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>extremely</td>
<td>somewhat</td>
<td>average</td>
<td>somewhat</td>
<td>extremely unlikely</td>
</tr>
</tbody>
</table>

156
6. How willing would you be to pay $1/month for pick-up composting service via a large, alleyway bin?

: 1 : 2 : 3 : 4 : 5 :

extremely somewhat average somewhat extremely
unwilling unwilling willing willing

7. How willing would you be to pay $1/month (total) for garbage removal and recycling services?

: 1 : 2 : 3 : 4 : 5 :

extremely somewhat average somewhat extremely
unlikely unlikely likely likely

8. If recycling and composting had an impact on global warming/climate change, would they be important issues?

: 1 : 2 : 3 : 4 : 5 :

unimportant of little moderately important very
importance important important

9. If recycling and composting helped create jobs, would they be important issues?

: 1 : 2 : 3 : 4 : 5 :

unimportant of little moderately important very
importance important important

10. If recycling and composting contributed large amounts of money to the county budget, would they be important issues?

: 1 : 2 : 3 : 4 : 5 :

unimportant of little moderately important very
importance important important

11. If recycling and composting saved or earned you money, would they be important issues?

: 1 : 2 : 3 : 4 : 5 :

unimportant of little moderately important very
importance important important
12. How often does the curbside recycling get picked up, if available?
   - twice a week □
   - once a week □
   - every two weeks □
   - once a month □
   - don’t know □

13. About how often do you put out the recycling bin for collection?
   - twice a week □
   - once a week □
   - every two weeks □
   - once a month □
   - about every other month □
   - I don’t recycle

14. Which of the following items can you place in the curbside recycling bins (check all that apply)?
   - newspaper □
   - glass bottles □
   - glass jars □
   - plastic bottles □
   - plastic grocery bags □
   - plastic tubs (yogurt, butter containers, etc.) □
   - cardboard □
   - aluminum cans □
   - plastic packaging (pretzel and chip bags, food wrappers, etc.) □
   - junk mail □
   - loose paper □
   - glass cups □
   - tin cans □
   - food scraps □
   - don’t know □

15. Do you need to separate your recyclables when placing them in the bin (for example, put all glass in one bin, plastic in another, etc.)?
   - yes □
   - no □
   - don’t know □

16. Where have you gotten information about Denver’s recycling program (check all that apply)?
   - newspaper □
   - internet □
   - radio □
   - TV □
   - school □
   - work □
   - booklet that comes with bin □
   - other (please list) ________________

17. Have you ever consulted Denver’s recycling website for waste management information?
   - I wasn’t aware there was a recycling website □
   - yes □
   - no □
   - I don’t use the internet □
18. What recycling method do you have available at home?
   small personal curbside bin (no wheels) □  large personal curbside bin (with wheels) □
   large community bin(s) □  pay for private company □  don’t recycle □
   other (please list)________

19. What, if anything, prevents you from composting regularly (mark all that apply)?
   composting service is unavailable □  do not want to store kitchen wastes in home □
   I’ve thought about it, but it’s not important □  never thought about it □
   my contribution to landfill is so small as to be unimportant □
   I have no use for it □  nothing - I compost regularly □
   I do not know how to compost □  other (please specify)________________________□

20. What, if anything, prevents you from recycling regularly (mark all that apply)?
   it is not available at my residence □  lack of space to store recyclables □
   it is inconvenient □  my contribution to the landfill is so small that it’s unimportant □
   I’ve never thought about it □  I’ve thought about it, but it’s not important
   takes too much time (cleaning containers, etc) □  do not want to separate materials □
   it’s too far to travel to the bin □  nothing - I recycle regularly □
   other (please list)____________□

21. What, if anything, prevents you, or whoever mows the lawn, from leaving grass clippings in yard by not using a bagging mower (mark all that apply)?
   it kills the grass □  never thought about it □  thought about it, but it’s not important □
   I don’t have a lawn □  I don’t mow my lawn □  other (please list)____________□

22. Do you have a home garden?
   vegetable garden □  flower garden □  no garden □
23. If yes, do you use your compost in your garden?

- vegetable garden
- flower garden
- N/A (no garden)

24. To what extent do you agree with the following statements? Please circle the appropriate number.

### a. The environment is forgotten too often when decisions are made

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td>agree</td>
</tr>
</tbody>
</table>

### b. If we over-use our natural resources, human development may be harmed in the future

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td>agree</td>
</tr>
</tbody>
</table>

### c. Nature and the environment have as much value as human beings

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td>agree</td>
</tr>
</tbody>
</table>

### d. Humans should not develop any more resources or land, in order to protect the natural environment

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td>agree</td>
</tr>
</tbody>
</table>

### e. Nature isn’t harmed by human changes

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td>agree</td>
</tr>
</tbody>
</table>
f. Human welfare should be our primary concern in the future
   : 1 : 2 : 3 : 4 : 5 :
   strongly disagree undecided agree strongly disagree
   disagree agree

g. The environment is of little concern to me
   : 1 : 2 : 3 : 4 : 5 :
   strongly disagree undecided agree strongly disagree
   disagree agree

h. Getting through daily life and surviving is what concerns me the most, not the environment
   : 1 : 2 : 3 : 4 : 5 :
   strongly disagree undecided agree strongly disagree
   disagree agree

25. Most people who are important to me think that I should recycle.
   : 1 : 2 : 3 : 4 : 5 : 6 :
   strongly disagree undecided agree strongly I don’t disagree
   agree know

26. Most people who are important to me think that I should compost.
   : 1 : 2 : 3 : 4 : 5 : 6 :
   strongly disagree undecided agree strongly I don’t disagree
   agree know

27. Composting at home is easy.
   : 1 : 2 : 3 : 4 : 5 :
   strongly disagree undecided agree strongly disagree
   agree

28. Recycling at home is easy.
   : 1 : 2 : 3 : 4 : 5 :
   strongly disagree undecided agree strongly disagree
   agree
29. Most of my friends/family compost.

:  1  :  2  :  3  :  4  :  5  :  6  :

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>undecided</th>
<th>agree</th>
<th>strongly disagree</th>
<th>I don’t agree</th>
<th>know</th>
</tr>
</thead>
</table>

30. Most of my friends/family recycle.

:  1  :  2  :  3  :  4  :  5  :  6  :

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>undecided</th>
<th>agree</th>
<th>strongly disagree</th>
<th>I don’t agree</th>
<th>know</th>
</tr>
</thead>
</table>

31. I do not create enough waste to justify composting.

:  1  :  2  :  3  :  4  :  5  :  6  :

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>undecided</th>
<th>agree</th>
<th>strongly disagree</th>
<th>I don’t agree</th>
<th>know</th>
</tr>
</thead>
</table>

32. I do not create enough waste to justify recycling.

:  1  :  2  :  3  :  4  :  5  :

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>undecided</th>
<th>agree</th>
<th>strongly disagree</th>
<th>I don’t agree</th>
<th>know</th>
</tr>
</thead>
</table>

33. Composting is too time-consuming to worry about.

:  1  :  2  :  3  :  4  :  5  :

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>undecided</th>
<th>agree</th>
<th>strongly disagree</th>
<th>I don’t agree</th>
<th>know</th>
</tr>
</thead>
</table>

34. Recycling is too time-consuming to worry about.

:  1  :  2  :  3  :  4  :  5  :

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>undecided</th>
<th>agree</th>
<th>strongly disagree</th>
<th>I don’t agree</th>
<th>know</th>
</tr>
</thead>
</table>

35. Generally speaking, it is important that my friends/family approve of what I do

:  1  :  2  :  3  :  4  :  5  :

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>undecided</th>
<th>agree</th>
<th>strongly disagree</th>
<th>I don’t agree</th>
<th>know</th>
</tr>
</thead>
</table>
36. Generally speaking, it is important that those who are important to me approve of what I do

: __1__ : __2__ : __3__ : __4__ : __5__ :

   strongly disagree undecided agree strongly disagree
   disagree agree

37. Composting on a daily basis is possible for me.

: __1__ : __2__ : __3__ : __4__ : __5__ :

   strongly disagree undecided agree strongly disagree
   disagree agree

38. Recycling on a daily basis is possible for me.

: __1__ : __2__ : __3__ : __4__ : __5__ :

   strongly disagree undecided agree strongly disagree
   disagree agree

39. If I wanted a recycling bin, the City of Denver would give me one for free.

: __1__ : __2__ : __3__ : __4__ : __5__ : __6__ :

   strongly disagree undecided agree strongly disagree
   disagree agree know

   Composting is something…

40. I do frequently

: __1__ : __2__ : __3__ : __4__ : __5__ :

   strongly disagree undecided agree strongly disagree
   disagree agree

41. I do automatically

: __1__ : __2__ : __3__ : __4__ : __5__ :

   strongly disagree undecided agree strongly disagree
   disagree agree
42. I do without having to consciously remember

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

43. that makes me feel weird if I do not do it

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

44. I do without thinking

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

45. that would require effort not to do it

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

46. that belongs to my daily routine

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

47. I start doing before I realize I’m doing it

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

48. I would find hard not to do

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

Composting is something…
49. I have no need to think about doing

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td></td>
</tr>
<tr>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

50. that’s typically “me”

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td></td>
</tr>
<tr>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

51. I have been doing for a long time

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td></td>
</tr>
<tr>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recycling is something…

52. I do frequently

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td></td>
</tr>
<tr>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

53. I do automatically

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td></td>
</tr>
<tr>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

54. I do without having to consciously remember

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td></td>
</tr>
<tr>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

55. that makes me feel weird if I do not do it

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
<td></td>
</tr>
<tr>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recycling is something…

56. I do without thinking

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

disagree agree

57. that would require effort not to do it

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

disagree agree

58. that belongs to my daily routine

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

disagree agree

59. I start doing before I realize I’m doing it

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

disagree agree

60. I would find hard not to do

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

disagree agree

61. I have no need to think about doing

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

disagree agree

62. that’s typically “me”

: 1 : 2 : 3 : 4 : 5 :

strongly disagree undecided agree strongly

disagree agree
63. I have been doing for a long time

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>strongly</td>
<td>disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly disagree</td>
</tr>
<tr>
<td></td>
<td>disagree</td>
<td>agree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you use a large cart with wheels, please answer the following questions.

64. How much do you recycle now, compared to when you had the smaller bins?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>much less</td>
<td>a little</td>
<td>about</td>
<td>a little</td>
<td>much more</td>
<td>I never had</td>
</tr>
<tr>
<td></td>
<td>less</td>
<td>the same</td>
<td>more</td>
<td>a small bin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

65. If you recycle less, why (mark all that apply)?

- too bulky
- bin is not big enough
- no place to store bin
- no room to store recyclables
- takes too long to separate materials
- other (please specify) ________________________________

66. If you recycle more with the larger bin, why?

- convenience of larger bins
- the bin is easier to see
- information about recyclables came with the bin
- other (please specify) ________________________________
If you live in an apartment building with more than 7 apartments in it, please answer the following question.

67. If you do recycle regularly, what service do you use?

private recycling company □  community bins on street/alley □
community bins at grocery stores □
other (please specify)__________________________________________ □
Section 2. Demographic Data. All information is strictly confidential, and will be anonymous.

68. What age category do you belong to?
   18-29 □  30-39 □  40-49 □  50-59 □  60-69 □  70+ □

69. What is your gender?
   male □  female □

70. How many years of formal education have you had?
   12th grade or less, no diploma □  high school or equivalent degree □
   some college, no degree □  Associate’s degree □  Bachelor’s degree □
   Graduate or professional degree □

71. What is your approximate combined yearly household income?
   less than 20,000 □  20,000-35,000 □  35,001-50,000 □
   50,001-75,000 □  75,001-100,000 □  100,000+ □

72. How many people live in your residence, including yourself?
   1 □  2 □  3 □  4 □  5 □  6 □  7 □  8+ □

73. Do you rent or own your home?
   rent □  own □

74. What type of residence do you live in?
   detached house □  apartment □  duplex □  town home □  other ________ □

75. Which political affiliation do you most identify with?
   Democrat □  liberal Democrat □  conservative Democrat □  liberal Republican □
   Republican □  conservative Republican □  don’t know □  Independent □
   Green □  Libertarian □  Other (please identify) □  ____________
   169
76. Who takes out the recycling most often (check all correct answers)?
   adult male □  adult female □  one certain child □  different children □
   all share duty equally □

77. What race/ethnicity do you identify with most strongly?
   White □  Black or African American □  Hispanic/Latino (of any race) □
   American Indian/Alaskan □  Asian □  Native Hawaiian or other Pacific Islander □
   Other (specify) __________ □  More than one race/ethnicity (list) __________ □

78. What language is most often spoken at your residence?
   English □  Spanish □  Other (please list) __________ □
Please use the space below to write any comments about the survey, any extra input you would like to provide, including how to improve recycling or add composting services in Denver. If possible, please provide reasons why you do or do not recycle and/or compost.

You have completed the survey. Thank you very much for participating!

Remember to fill in your phone number or email address if you’d like to enter in the drawing for the $50 prize!