**The Role of Ecolabel Knowledge on Consumers' Purchasing Behavior:**

**Taking EPA Safer Choice as an Example**

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**ABSTRACT**

As modern technology becomes increasingly advanced and there are more and more chemicals appearing across all dimensions in daily life, consumers need to consider both the environmental and health consequences of what they purchase. To help consumers easily distinguish between chemical safe products and other products, promote health and safety to both consumers and the environment, EPA Safer Choice ecolabel was developed to mitigate the gap. For consumers to be willing to purchase eco-labeled products, it is crucial that they have the knowledge of what ecolabels are, understand what they represent and trust the ecolabel. Through collecting surveys from 192 respondents in the Bay Area, the direct relationship between ecolabel knowledge and consumer behavior was investigated, while mediation analysis was also applied to examine the mediation effect of trust. The findings suggested that EPA Safer Choice ecolabel knowledge did not have direct influence on purchase behavior for both EPA Safer Choice labeled cleaner and laundry detergents. EPA Safer Choice ecolabel knowledge had direct positive impact to trust on EPA Safer Choice label, but there was only direct impact of trust on purchase behavior for laundry detergent. The mediation effect of trust was only confirmed in laundry detergent but not in cleaner. The result confirmed the necessity of ecolabel knowledge education, while revealed the heterogeneity of consumers' perception towards different EPA Safer Choice product categories. Further research with larger sample size, more regions and product categories can be performed to deliver a broader landscape of consumers' perception towards EPA Safer Choice Program.

**KEYWORDS**

**INTRODUCTION**

As modern technology becomes increasingly advanced and there are more and more chemicals appearing across all dimensions in daily life, consumers need to consider both the environmental and health consequences of what they purchase. To help consumers easily distinguish between chemical safe products and other products, promote health and safety to both consumers and the environment, EPA Safer Choice ecolabel was developed to mitigate the gap. EPA Safer Choice ecolabel is issued by the United States Environmental Protection Agency, which aims to help consumers, businesses, and purchasers find products that perform and contain ingredients that are safer for human health and the environment. Safer Choice is also a crucial part of the EPA's Pollution Prevention (P2) program, which includes practices that reduce, eliminate, or prevent pollution at its source, such as using safer ingredients in products (EPA Safer Choice 2020). Given this existing ecolabel, it is necessary to promote the existence of EPA Safer Choice in consumers' purchasing decision and therefore reduce the negative impact of chemicals to human health and the environment.

For consumers to be willing to purchase eco-labeled goods, it is crucial that they have the knowledge of what ecolabels are and understand what they represent. Knowledge is considered as an integral part of attitude (Fabrigar, Petty, Smith, & Crites 2006) and it is commonly understood that greater knowledge is related to a greater influence on behavior (Fabrigar et al. 2006; Nielsen and Thogersen 2015). The same logic can be applied to ecolabel knowledge which refers to whether and how much do people know about a specific ecolabel. Ecolabels are effective only if consumers know what they are and what they represent (Horne 2009; Thogersen 2000). In a survey of more than 2000 adult U.S. residents in February 2020, only 43% of consumers reported familiarity with the EPA Safer Choice program and only 37% of them said they have seen the Safer Choice label on store shelves (EPA Safer Choice 2020). This survey result reveals the lack of knowledge about, and familiarity with, the EPA Safer Choice program among consumers in the United States. Therefore, the knowledge of EPA Safer Choice Program should be targeted as the starting point to influence consumers' behavior in purchasing EPA Safer Choice-labeled products.

Having the ecolabel knowledge is not enough for establishing the eco-labeled products market since the consumers do not have the technical expertise and resources to verify the credibility of eco-labeled products (Ying, Biao, Shanyong, & Wenpei 2020), hence, consumers'

trust in ecolabel is an important premise in purchasing decision-making process. It has been studied that trust can give people a better expectation of results and therefore leads to a more positive intention on behavior (Nuttavuthisit and Thogersen 2017). When consumers are uncertain about the credibility of the ecolabel, this may result in confusion and thus reduce their intention in purchasing eco-labeled products. Such uncertainty should be mitigated through building consumers' trust on eco-labeled products and should be achieved via the emphasis of credibility in consumers' ecolabel knowledge (Khan, Andrea & Michael 2016). Research has been done to show that eco-labels certified third parties usually represent higher reliability, especially those certified by a public authority including governmental agency and environmental groups (Janssen, Hamm 2011). Therefore, trust should also be studied not only on its direct impact on consumers' purchasing intention, but also its role as a mediation factor between ecolabel knowledge and purchasing behavior.

In this study, I will explore the role of ecolabel knowledge in affecting purchasing behavior, taking EPA Safer Choice as an example. I will investigate how ecolabel knowledge directly improve consumers' purchasing behavior regarding EPA Safer Choice labeled cleaner and laundry detergent. I will also examine mediating effect of trust in the relationship between ecolabel knowledge and purchasing behavior. I hypothesize that ecolabel knowledge is positively related to trust and purchasing behavior for eco-labeled products; trust is positively related to purchasing behavior for eco-labeled products. I use stated preference as an indicator for measuring purchasing behavior. To answer those questions, I collect data on consumer knowledge about the EPA Safer Choice Program, trust toward EPA Safer Choice products, as well as the stated preferences compared to products that are not eco-labeled. By learning the relationship between ecolabel knowledge, trust and behavior, this study can be helpful in developing appropriate marketing strategies for EPA Safer Choice labeled products for both EPA Safer Choice Program and retailors.

## BACKGROUND

**Household cleaning products and their environmental impact**

Household chemical products are very common in people's daily lives. Various household cleaning products have been developed to remove dust and dirt, maintain household surfaces, and disinfect. While household cleaning products can provide aesthetic and hygiene benefits, they may cause severe indoor air pollution. Residue from cleaning products and cleaning activity (dusting, vacuuming, sweeping) has been shown to worsen indoor air quality (IAQ) by redistributing particulate matter (dust, dirt, human skin cells, organic matter, animal dander, particles from combustion, fibers from insulation, pollen, and polycyclic aromatic hydrocarbons) to which gaseous or liquid particles can be absorbed. The concentration of such particulate matter and chemical residual will be highest immediately after cleaning and will decrease over time at a rate that depends on levels of contaminants, air exchange rate, and other sources of chemical residual (Nazaroff and Weschler 2004). One of the most concerning household chemicals are Volatile organic compounds (VOCs)  such as formaldehyde, toluene, and limonene (Burton, 2007). VOCs are released from many household cleaning products such as disinfectants, polishes, floor waxes, air-freshening sprays, all-purpose cleaning sprays, and glass cleaner. VOCs tend to evaporate and then to be inhaled into the lungs or absorbed by dust, which can also be inhaled (Wolkoff et al. 1998). Spray cleaning products are especially problematic and may aggravate symptoms of adult asthma (Zock, et al. 2007), respiratory irritation, childhood asthma, wheeze, bronchitis, and allergies (Raizenne et al. 1998).

Besides contributing to air pollution, household chemicals may enter the waterway after usage, which will cause complex impact to the environment. Chemicals used for cleaning toilets, sinks, and bathtubs can find their way into sewage water and can often not be effectively removed or filtered. As the residual chemicals enter waterway uncontrollably, this may cause eutrophication where plant and algal grow excessively due to the increased availability of one or more limiting growth factors needed for photosynthesis. As time goes, dense vegetation that clogs waterways, crowding out animal life and other marine plants. At the end of these plants' life cycle, they die in large masses, decaying and depleting the oxygen in the water. Algae then grows, and the animals like freshwater shellfish, fish and others will die off as well; the die-offs cause more decay. Therefore, the water is no longer suitable for drinking, cooking, or bathing.

**EPA Safer Choice Program**

EPA's Safer Choice Program, previously known as 'Design for the Environment (DfE) Safer Product Labeling Program', was founded in the early 1990s as a voluntary program to help companies consider human health, environmental, and economic effects of chemicals and technologies (EPA Safer Choice 2021). The Safer Product Labeling Program was started as a project with the chemical-based products industry (e.g., cleaners and detergents) to help leading companies use safer chemicals to make high-performing products. DfE developed this certification program based on its Standard for Safer Products (EPA Safer Choice 2021) and safer chemical criteria, allowing companies to differentiate their products in the marketplace and making it easier for consumers and business purchasers to identify products that are safer for workers, families, pets, and the environment.

The EPA Safer Choice Program evaluates each ingredient in a formula by following Master and Functional-Class Criteria documents which define the characteristics and toxicity thresholds for ingredients that are acceptable in EPA Safer Choice products. EPA Safer Choice standard is a science-based criteria that defines safer chemistry by chemical class, aiming to help the industry innovate and develop safer chemicals and chemical-based products. EPA Safer Choice focuses its review of ingredients on the key environmental and human health characteristics of concern within each type of product. This approach allows formulators to use those ingredients with the lowest hazard in their functional class, while still formulating high-performing products. The EPA Safer Choice Criteria are based on EPA expertise in evaluating the physical and toxicological properties of chemicals, and while they incorporate lists of chemicals of concern, they go far beyond these lists to ensure that EPA Safer Choice products contain only the safest possible ingredients (EPA Safer Choice 2021).

EPA Safer Choice Program has strict and standardized processes for product certification. After becoming familiar with the EPA Safer Choice Program, applicants must fully disclose all ingredients in their product to an EPA Safer Choice-qualified third-party profiler. The third-party profiler then will compile all hazard information available on each chemical, including detailed structure, physical-chemical properties, human health, environmental toxicology, and regulatory/administrative status. Following third-party profiling, EPA Safer Choice program will assess each ingredient in formulation within its functional class, and identify areas for improvement, safer alternatives, or additional information needs. After the product assessment, EPA Safer Choice and third-party profilers will communicate to the applicant about the assessment

and potential recommendations for improvement for entering the partnership. If qualified, EPA Safer Choice and the applicant will discuss partnership agreement, key user and environmental benefits, ingredient disclosure and company signatory. Once the partnership agreement is signed, EPA Safer Choice and applicant can decide how to announce the partnership, plan for the near-term activities and start to label their product with 'EPA Safer Choice' on the package. (EPA Safer Choice 2021).

**Methodology**

*Choice experiment*

Choice experiment is a method to model the decision process of an individual or group via revealed preferences or stated preferences made in the study context. It uses discrete choices to infer how the participants rank the items on some relevant scale. Choice experiment is recognized as the most suitable method for estimating consumers' willingness to pay for quality improvements in multiple dimensions (Center of International Economics 2001). A choice experiment usually includes the following steps: identify good or service to be valued; decide which attributes should be used describe product; construct survey to conduct the experiment; administrate the survey to the sample participants; analyze the data. This study used stated preference to figure out consumers' preference among given choices. Stated preference uses the choices made by individuals under experimental conditions to estimate consumers' values (Golek and Jennifer 2005). In this study, stated preferences are obtained through a discrete choice experiment in which participants must choose their single preference from a group of items. This yielded the required results to understand consumer purchasing behavior in EPA Safer Choice products.

**METHODS**

**Survey design**

The first part of the survey was a choice experiment. Choice experiments were usually used to derive the individual's marginal utility by exploring the trade-off between different attributes of

a product when making purchase decisions (Mazzochi and Guido 2021). In this study, participants were exposed to a set of choices for each product category. By manipulating the conditions in which consumers make a choice it is possible to infer information about preferences for specific attributes (Mazzochi and Guido 2021). To examine how important the ecolabel is in consumers' purchasing decisions, a second set of choice experiments was provided with an adding attribute of ecolabel. Due to the condition setting, the survey is not able to shuffle attributes which means the common econometrics approach to choice experiment could not be applied in this research. Therefore, we instead rated participants' stated preferences to explore the relationship between knowledge, trust and behavior.

The second part of the survey was ecolabel knowledge evaluation. There were two sections in this part: general familiarity and ecolabel knowledge test. In the general familiarity part, the participants were expected to rate their familiarity towards ecolabels based on a 0-10 likert-type scale. In the ecolabel knowledge test part, the participants should judge if the given statement about ecolabel is true or false. The answers in both parts will be graded and the total score will be the knowledge score for each participant.

The third part of the survey was trust evaluation. The participants were expected to demonstrate their level of trust based on 1-5 likert-type scale. The answers will be graded and the total score will be the trust score for each participant.

The last part of the survey was about demographics. Information about gender, age, ethnicity, and political affiliation of the participants would be collected and would be analyzed in the later analysis.

**Measures**

All constructs were measured by multiple items, and each item was evaluated by a different scale depending on construct. In the choice experiment section, choosing EPA Safer Choice product as the first choice will receive the highest point, followed by choosing 'Earth Friendly Product' labeled product, and no label. In the knowledge evaluation section, true answers received points while wrong or uncertain answers received zero points. In the trust evaluation section, strong trust desire received the highest score and least trust desire received the lowest score. All the scores in each section were aggregated and normalized for the later linear regression analysis.

**Sample and data collection**

A convenience sample of 192 respondents was surveyed. Due to the covid-19 pandemic, the questionnaire was distributed online at Bay Area reddit, Craiglists, and Facebook Groups. A mixed sample was deemed appropriate since student and consumer knowledge and understanding of environmental issues are similar (Synodino 1990). Respondents were screened by doing a stated preference choice experiment, knowledge assessment and trust evaluation. After data cleaning, 168 survey results were valid for further analysis (Table 1). The mean age of participants was 34.06 years old (SD=11.25), while 58.33% were female, 32.14% were male, and 2.38% were non-binary and 7.14% prefer not to say. In terms of participants's race and ethnicity, there were 13 unique combinations and White/Causasian had the highest frequency among participants. Among the participants, 53.66% were democrat, 26.83% were lean democrat, 1.83% were republican, 6.71% were lean republican, and 10.98% were not lean.

**Table 1: Demographics**

| Demographics | Frequency | Percentage |
|---|---|---|
| *Gender* | | |
| Female | 98 | 58.33 |
| Male | 54 | 32.14 |
| Non-binary / third gender | 4 | 2.38 |
| Prefer not to say | 12 | 7.14 |
| *Age* | | |
| 18-24 | 37 | 22.98 |
| 25-34 | 50 | 31.06 |
| 35-54 | 66 | 40.99 |
| 55 and above | 8 | 4.97 |
| *Ethinicity* | | |
| Asian/Pacific Islander | 32 | 19.05 |
| Black/African American | 5 | 2.98 |
| Hispanic/Latino | 8 | 4.76 |
| Hispanic/Latino,Asian/Pacific Islander | 1 | 0.6 |
| Hispanic/Latino,Native American/American Indian | 3 | 1.79 |
| Other | 9 | 5.36 |
| White/Caucasian | 93 | 55.36 |
| White/Caucasian,Asian/Pacific Islander | 10 | 5.95 |
| White/Caucasian,Asian/Pacific Islander,Other | 1 | 0.6 |
| White/Caucasian,Black/African American | 1 | 0.6 |
| White/Caucasian,Hispanic/Latino | 3 | 1.79 |
| White/Caucasian,Hispanic/Latino,Native American/American Indian | 1 | 0.6 |
| White/Caucasian,Other | 1 | 0.6 |
| *Political Affliation* | | |
| Democrat | 88 | 53.66 |
| Lean Democrat | 44 | 26.83 |
| Lean Republican | 11 | 6.71 |
| No Lean | 18 | 10.98 |
| Republican | 3 | 1.83 |

**Data analysis method**

     To explore the role of ecolabel knowledge in behavior as well as the mediation impact of trust, Lavaan package in R was used to perform mediation analysis. Since the typical mediation analysis which is called the Sobel Test (Delta Method) strictly assumes the sampling distribution of indirect effect is normally distributed, we used the resampling method and specifically the

percentile bootstrapping to perform the test. Path models were built and tested after bootstrapping, giving direct and indirect effect results between each attribute for further hypothesis testing. Both the models and the analysis for cleaner and laundry detergent were built and performed separately.

Structural equation modeling (SEM) was adopted to conduct the path analysis in this study (Figure 1). Path analysis is a method to discern and assess the effects of a set of variables acting on a specified outcome via multiple causal pathways. In this way, the present study employed a resampling method in R studio to analyze the data and test the hypotheses.
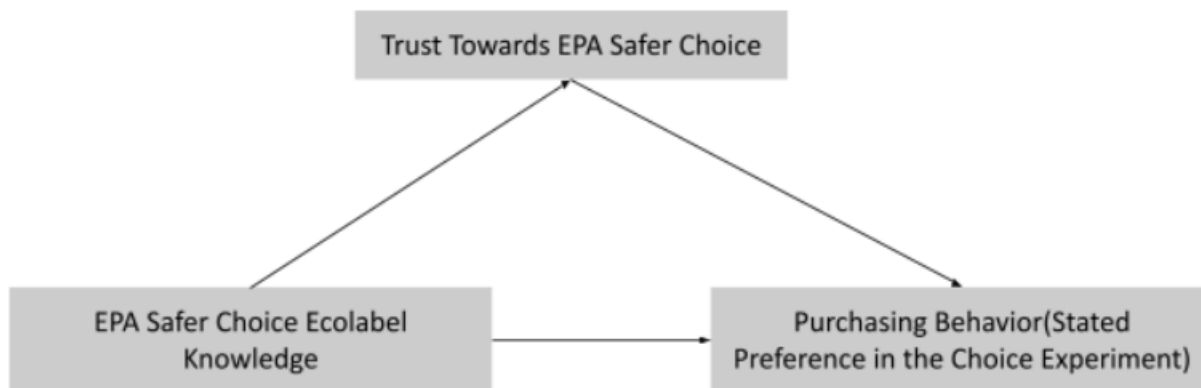


**Figure 1. Structural equation modeling**

## RESULTS

### Structural model and hypotheses testing

This study tested all its hypotheses in the structural model using a bootstrap sample of 5000 with 95% confidence intervals.

For cleaner, ecolabel knowledge has a strong, direct and positive impact on trust to EPA Safer Choice ecolabel ($\beta$=0.294, p=0.000). However, the result did not endorse the hypothesis of a direct, significant, positive relationship between trust on EPA Safer Choice ecolabel and purchasing behavior, and thus the hypothesis was failed to be rejected ($\beta$=0.058, p=0.511). The result did not support the hypothesis of the direct, positive relationship between ecolabel knowledge and purchasing behavior, instead suggesting a negative non-significant relationship, thus the hypothesis was failed to be rejected as well ($\beta$=-0.063, p=0.409).

**Table 2: SEM results: direct effect for cleaner**

|  | Direct Effect | Standard Error | P-Value |
|---|---|---|---|
| Knowledge->Trust | 0.294 | 0.065 | 0.000 |
| Trust->Behavior | 0.058 | 0.088 | 0.511 |
| Knowledge->Behavior | -0.063 | 0.076 | 0.409 |

For laundry detergent, ecolabel knowledge has a strong, direct and positive impact on trust to EPA Safer Choice ecolabel ($\beta$=0.294, p=0.000). Trust on EPA Safer Choice also had a strong, direct and positive impact on purchasing behavior ($\beta$=0.166, p=0.016). However, the result showed no relationship between ecolabel knowledge and purchasing behavior is not significant, thus the hypothesis was failed to be rejected ($\beta$=0.000, p=0.995).

**Table 3: SEM results: direct effect for laundry detergent**

|  | Direct Effect | Standard Error | P-Value |
|---|---|---|---|
| Knowledge->Trust | 0.294 | 0.065 | 0.000 |
| Trust->Behavior | 0.166 | 0.069 | 0.016 |
| Knowledge->Behavior | 0.000 | 0.079 | 0.995 |

To conduct a significance test of the hypothesized mediated relationship, 95% bias-corrected bootstrap confidence intervals were constructed from 5000 bootstrap samples (MacKinnon et al. 2004). Meditations were deemed 'significant' when the confidence intervals do not include zero. Using the procedure, the mediation effect of trust was only supported in laundry detergent ($\beta$=0.049, p=0.016), while was rejected in cleaner($\beta$=0.017, p=0.513). This result showed that trust has an indirect positive effect on behavior only in laundry detergent but not in cleaner.

**Table 4: SEM results: indirect effect for cleaner and laundry detergent**

|  | Indirect Effect | Standard Error | BootLLCL | BootULCL | P-Value |
|---|---|---|---|---|---|
| Cleaner: Knowledge->Trust->Behavior | 0.017 | 0.026 | -0.038 | 0.065 | 0.513 |
| Detergent: Knowledge->Trust->Behavior | 0.049 | 0.020 | 0.007 | 0.089 | 0.016 |

## DISCUSSION

The main objective of this study was to examine the role of EPA Safer Choice ecolabel knowledge on consumers' purchasing behavior for EPA Safer Choice labeled products. The study also incorporated consumer trust in EPA Safer Choice ecolabel and examined its mediation effect between knowledge and behavior. The findings suggested that overall, EPA Safer Choice ecolabel knowledge did not have direct influence on purchase behavior for both EPA Safer Choice labeled cleaner and laundry detergents. EPA Safer Choice ecolabel knowledge had direct positive impact on trust in EPA Safer Choice label for both cleaner and laundry detergent, but there was direct impact of trust on purchasing behavior only for laundry detergent. The mediation effect of trust was only confirmed in laundry detergent but not in cleaner.

**Direct impact of EPA Safer Choice knowledge on behavior**

The result shows that there was no significant relationship between EPA Safer Choice ecolabel knowledge and consumer behavior for both cleaner and laundry detergent. Many previous studies had found that ecolabel knowledge was positively related to consumers' purchasing behavior, but none of them examined the impact of knowledge about EPA Safer Choice exclusively. This is important since EPA Safer Choice ecolabel is a strategic communication tool aimed to promote consumers' awareness about chemical safety, their personal health, and the environment. As this study found there was no direct relationship between consumers' knowledge about EPA Safer Choice and the purchasing behavior of EPA Safer Choice products, there was a question mark on if there is a need to educate consumers about EPA Safer Choice ecolabel. Even though non-significant, the negative relationship between EPA Safer Choice ecolabel knowledge and purchasing behavior in cleaner cannot be ignored. This finding was consistent with a previous study (Taufique et al. 2017) in which ecolabel knowledge had a direct negative influence on PECB (pro-environment purchasing behavior). This may be because consumers were skeptical about ecolabel information and they were deterred from undertaking corresponding purchasing behavior (Chen and Chang 2013).

**The mediating effect of trust**

The mediating role of trust was only detected in laundry detergent but not in cleaner. This result is something unexpected but reasonable since previous studies had recognized that consumer difficulty in understanding what ecolabels are communicating will lead to mistrust (Thogersen et al. 2010). Moreover, third-party ecolabels had been found to achieve higher levels of consumer trust (Atkinson and Rosenthal 2014) and were more competitive to gain consumer market (Testa et al. 2015). As a federal level agency's program, EPA Safer Choice program should achieve a higher level of trust, implicating it is necessary for the program to increase the credibility of EPA Safer Choice ecolabel. Regarding why the mediation effect of trust is only significant in laundry detergent but not in cleaner, one possible explanation can be found in the mechanism of how the consumers are aware of risk. Previous research has indicated that while consumers are aware of the risks of chemical household products, they do not spontaneously think of such risks (Buchmüller et al. 2020). In fact, consumers have to be prompted to think of the risks. When asked about their spontaneous associations regarding such products, consumers are more likely to think about the way they use these products or about product characteristics such as the smell, rather than spontaneously mentioning the risks of such products (Buchmüller et al. 2022). In this context, consumers may be more aware of the risk in laundry detergent than the risk in cleaner since laundry detergent usually has more direct human skin contact than cleaner. None of any previous studies had examined the distinction of trust and behavior on different product categories under the same ecolabel, but this research exposed that this heterogeneity does exist and is worthwhile to investigate in depth.

**Limitations and further directions**

Although much care was taken to optimize the study, several limitations are noteworthy. First, a small convenience sample was adopted via online platforms, which could make the results biased. More respondents, more randomized respondents, and more data collection methods would deliver better scenario as they can reduce biases significantly. Second, all the respondents of the survey are from the Bay Area, meaning there is a strong political and racial characteristic in the sample. In this sense, data from other regions or cities may lead to a completely different result,

and this research can only be representative for the Bay Area. Third, only trust is selected to serve as the mediation factor in this research setting, however, there are other contextual factors going on that are worth being investigated, such as environmental concern, attitude to ecolabel, etc. Fourth, this study looked into the relationship between factor and factor but not causal inference. To develop more strategic measures to promote consumers behavior of EPA Safer Choice products, stricter control of linear regression and randomized treatment are required to establish the causal relationship between knowledge, trust and behavior. Finally, EPA Safer Choice products are not limited to cleaner and laundry detergent, there are also more brands that are EPA Safer Choice labeled but not chosen in the survey design. Since the heterogeneity of models is detected in this research, studies that include more product categories and brands are suggested in order to have a better understanding of consumer perceptions of EPA Safer Choice Program.

**Conclusion**

This research used mediation analysis to examine the relationship between ecolabel knowledge and purchasing behavior for EPA Safer Choice labeled cleaner and laundry detergent. It also explored the mediation role of trust to EPA Safer Choice ecolabel between knowledge and behavior. According to the result, there is no direct relationship between ecolabel knowledge and purchasing behavior. Additionally, the mediation effect of trust was only tested to be valid in laundry detergent. This finding illustrated that there is heterogeneity of consumer behavior and trust when facing different products under the same ecolabel, implicating that retailer may design marketing strategies for different categories of products accordingly. Moreover, the EPA Safer Choice program may conduct more public education and information disclosure to promote consumers' perception as well as the credibility of the EPA Safer Choice program. Since this research used a small convenience sample from the Bay Area, a larger scale of the research can be done to understand the broader landscape of EPA Safer Choice ecolabels as well as other ecolabels. Research that includes more brands, contextual factors and product categories will also be beneficial for multiple stakeholders to improve both household chemical safety and to prevent chemical pollution to the environment.

**ACKNOWLEDGEMENTS**

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