Trends in Consumer Preferences for Product Customization and their Application in Product Design

Carter Powell, Sheng Yang[*],
School of Engineering, University of Guelph, Guelph, Canada
*Email : syang19@uoguelph.ca

Abstract— Consumer preferences play an important role in the decision to customize a product. The collection of consumer preferences can be a challenging task and most methods require significant effort while only focusing on one specific product or product type. A popular method of collecting consumer preferences is a survey as it is easy to administer and can be tailored to gather specific desirable information. In this paper, a survey is developed to gather consumer preferences for product customization with a focus on identifying trends amongst these preferences. User preferences are correlated to factors of success in customization and categorical definitions of product attributes. Twenty-five products were evaluated, with one hundred total responses collected. The results show the existence of product clusters that represent trends amongst consumer preferences for customization. The trends and clusters identified have potential applications in the design of novel customized products by using categorical representations to generalize the findings. This method of generalization can provide cost and time savings in the product design cycle for future customized products by reducing the effort required to elicit consumer preferences.

Keywords : Product Design, Product Customization, Consumer Preferences, Crowd Sourcing

I. INTRODUCTION

Product customization can be defined as tailoring products to meet the needs of individual customers. Offering customized products can provide benefits to both producers and consumers. Consumers receive products that better suit their needs and are more valuable to them [1]. They also feel more attached to the product due to the personal nature of the product [2]. Companies can generally charge more for customized products [3] and attract new customers with unique product offerings [4].

The decision to customize is tied to the desires of the consumers and the demand that exists in the market [5], [6]. Offering customization can be costly [3] and time consuming [1] and is only beneficial if the consumers are willing to pay and wait for a customized version of the product. Deciding which features of the product should be customized also presents a challenge for product designers.

Offering options for customization that are undesirable can have a negative impact on the success of a companies' product line.

There are several methods of eliciting consumer preferences and implementing them in the product design process. Chin and Porage proposed a method involving multi-attribute utility theory [7]. The goal is to optimize the product parameters using an Iona framework. This involves explicitly asking users' preferences and constraints for a product, identifying purchasing situations and stereotypes, then using integer programming to find an optimal product solution for the consumer. Another method of obtaining consumer preferences involves using customer reviews. This can be done using natural language processing (NLP). An example involves a model named the bidirectional encoder representations from transformers with new convolutional net (BERT-NER) [8]. User preferences, sentiments and needs are extracted from online product reviews with the BERT-NER model and processed to identify the needs and desires of customers in terms of product attributes. Another similar approach uses online customer reviews and part of speech tagging [9]. Here, a different NLP model picks out specific nouns and noun phrases, then measures frequency of use to generate a list of product attributes and importance levels.

Surveys are another method that can be used to elicit consumers preferences and gather important information for customization. Wellige and Steiner utilized surveys to contact European manufacturers and compile a list of indices to evaluate a firm's capabilities for customization [10]. From their results, they concluded that customer surveys were an important factor of success in measuring a firm's ability to develop the solution space of their product and identify the attributes important to consumers. Yao and Xu used stated preferences surveys to collect information on consumer preferences for customization and predict market demand in dynamic environments to help with product configuration strategies [11]. Their work focused on apparel and involved first presenting respondents with four items of clothing and asking them to choose their favorite item assuming attributes like cost and brand were the same. They then collected information on the consumers such as gender, age, disposable income, etc. and had them evaluate additional products. This work had promising results in terms of meeting the goals set out by the authors,

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however the model requires a large amount of survey data that can be costly and difficult to obtain.

Use of a traditional survey to collect consumer preferences on a specific product can be time consuming and costly. The information gathered from these surveys is also only applicable to the specific product presented in the survey. This paper presents a survey model aimed at gathering consumer customization preferences for a variety of products using categorically designed questions to examine the trends that exist amongst these preferences. The goals of utilizing this survey model can be divided into three main categories. The first is to determine whether certain products are desirable for customization, the second is to determine what kinds of product attribute categories would be desirable for customization and the third is the identification of trends to evaluate the generalizability of the collected data. Trends in the data can be used for novel products to aid in evaluation of the suitability for customization and in the design process to eliminate the need for new data collection on consumer preferences. The paper is organized as follows. First, the design of the survey is discussed in section II along with how the data was collected. Section III evaluates the results of the consumer preference surveys and identifies trends discovered in the collected data. Section IV addresses the generalizability of the data and how it can be used in the customization process. The paper concludes with closing remarks in section V.

II. SURVEY DESIGN

Online surveys have been shown to be a time effective method for collecting data [12]. Results are automatically stored in a database that can be easily imported into other software and users are able to easily answer questions at their leisure. The distribution of surveys can present a challenge as it is often difficult to collect responses. There are several options available to distribute surveys, including the use of email, online forums, and professional associations. Previous works have found that online forums have the highest response rate when compared to other channels for distribution [12].

A crucial element of effective data collection is a user-friendly and easy to use design [13]. Considering the survey is intended to gather responses from all demographics, each question needs to be simply worded and easy to understand. These questions must also be carefully crafted to elicit the information to attain the goals of the study.

Five different surveys were used to collect the data on twenty-five different products. The twenty-five products were distributed evenly across the five surveys. Respondents were shown a picture of the product along with a generic name for the product and the price. The product pictures were sourced from Amazon along with the accompanying price information. Generic names were used to avoid any brand bias that might influence consumer preferences. The respondents were then asked a series of questions relating to the suitability of the product for customization and their preferences for customization of attributes, which are detailed in the following subsections.

A. Suitability of the the Product for Customization

The suitability of a product for customization can be determined by the factors of success in customization. Factors of success in customization refer to key metrics or indicators that can reveal how effective customizing a product will be for a firm. One of the primary objectives of customization is to increase the utility of a product and better suit the needs of customers. The added utility and increased usefulness are what create value for the customer and ultimately drives them to purchase the customized product over a mass-produced product. To tailor products to the specifications of individual customers, there is an added cost both monetarily and time wise since traditional mass production techniques cannot be used. Sometimes specialized equipment is needed to produce the products and more hours of labor are needed in the manufacturing process. In the interest of keeping the survey short and simplistic to target all demographics and maximize the response rate, three areas of primary concern were chosen to evaluate products on their suitability for customization. These three areas include the usefulness and appeal of customization, the willingness to pay for a customized product and the willingness of consumers to wait for a customized product.

B. Product Attribute Categories

Product attributes can be classified into different categories based upon the functions and characteristics of the product. To make the collected data generalizable for other similar products, categorizing the attributes is essential. Given the nearly infinite possibilities of product attributes, it would be impossible to collect consumer preference data on every conceivable attribute.

Several works have utilized the classification of product attributes with a variety of goals in mind. One such work uses online product reviews to determine consumer sentiments towards products and incorporate these inputs into the design process [14]. A kettle is used as an example product, where an NLP and machine learning based model identifies user sentiments towards the product and extracts frequently mentioned aspects of the product. These aspects are classified in four categories: part, material, action, and performance. In a review of smart connected products, expert opinions and other literature were used to determine different types of attributes [15]. In this work, four attribute clusters were identified: appearance, function, experience and meaning. Frutos et al. proposed a decision support model for customization that utilized specific customer inputs to help in the product configuration process [16]. In their work they use the example of an apartment to illustrate their decision support model and gather customer preferences in several attribute categories, then determine optimal configurations for these customers. The categories they utilize are price, aesthetics, durability, cleanliness, interchangeability, delivery time and resale.
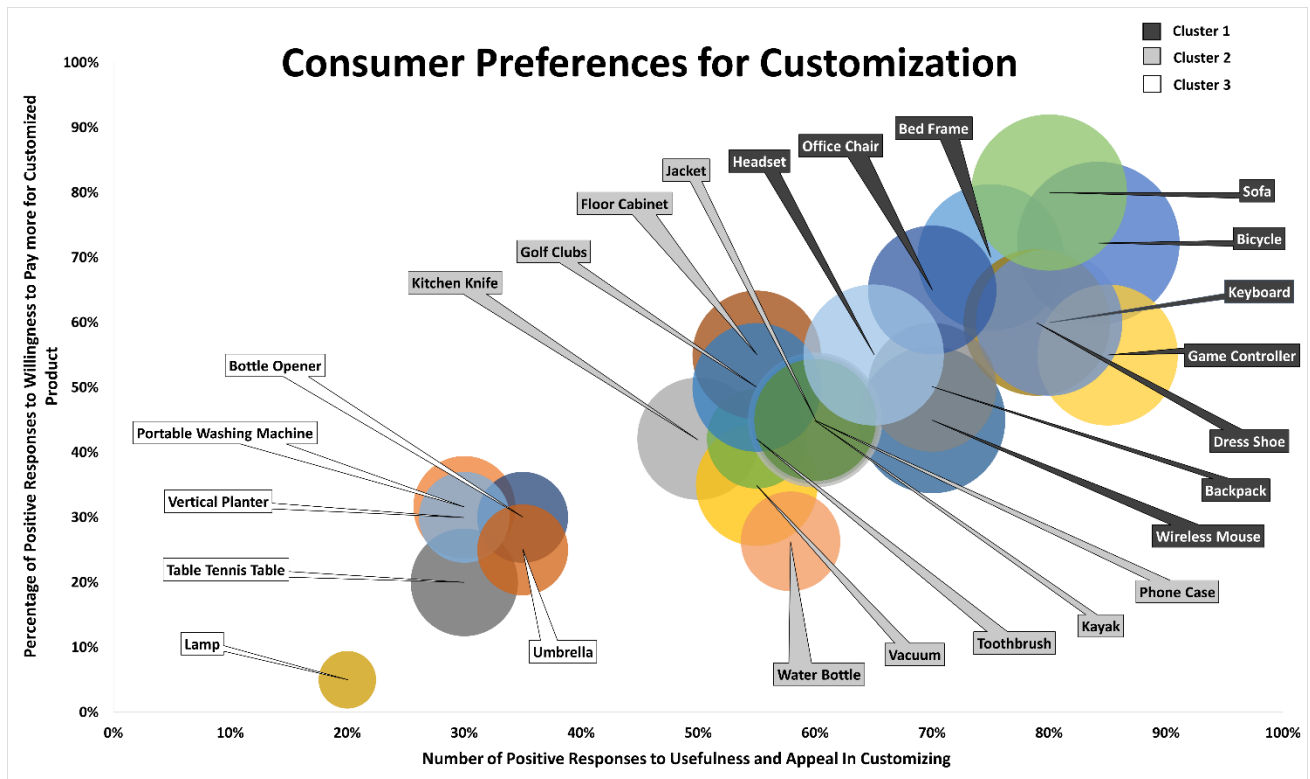
Figure 1. Consumer Preferences for Product Customization. Larger bubble size means increased willingness to wait to receive customized product.

Based on the literature reviewed, five different categories are proposed to be evaluated in this survey: aesthetics, form, functional features, complexity, and quality/cost. Aesthetics refer to any features of the products that relate to aspects of the coloring, style, texture, material, and overall appearance. Form relates to the shape of the product and the size. Functional features are any part of the product that relates to the function of the product and can be utilized by the consumer. Complexity is the ability to add a lot of features to the product and change the power source. Quality/Cost relates to aspects of the durability of the product, the perceived quality of the product and aspects relating to how much the product will cost.

In the survey, respondents are provided with brief descriptions of what each category of attributes represents. Then, they are asked to rate their interest in customizing each category of attributes on a scale ranging from "no interest" to "very interested".

C. Data Collection

Data collection took place over the period of several weeks with the objective of obtaining one hundred total responses between the five different surveys [17]–[21], with equal distribution. Based on guidance from literature, online forums provide the best response rate for surveys [12]. Several different online forums were targeted, namely on the social media platforms Reddit and Facebook. Specific groups on these platforms oriented around surveys were utilized, with posts being made regularly including a brief overview of the goals of this study. Respondents were allowed to skip questions to maximize the response rate,

this is considered in the results as all metrics are evaluated as percentages.

III. RESULTS

A. Prefernces for Customization

Consumer preferences towards customization were evaluated on three metrics as described in Section II (A). Figure 1. shows a graphical representation of the responses collected. The figure presents the percentage of positive responses to increasing usefulness and appeal for customization on the X-axis and the number of positive responses to an increased willingness to pay on the Y-axis. The size of the bubbles are indicative of the consumers' willingness to wait to receive a customized version of the products. Larger bubble sizes mean a greater willingness to wait for customization.

From Figure 1, there is a clear positive correlation between consumers seeing the increased usefulness and appeal of customized products and their willingness to pay more for customized products. This trend is likely driven by the fact that the increased usefulness and appeal for a customer makes the product more valuable for them thus increasing their willingness to pay more for it. There is also a positive correlation between the willingness to pay, the usefulness and appeal of customization and the willingness of consumers to wait for a customized product. This can be seen in the figure as the bubble sizes increase with the X and Y axis. Again, the increased usefulness and appeal is likely influencing the willingness of the customer to wait to receive the product.

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Table 1. Consumer Attribute Preferences for Customization

	Aesthetics					Functional Features					Form					Complexity					Quality/ Cost				
Cluster 1																									
Bed Frame	10%	10%	40%	20%	20%	5%	11%	11%	32%	42%	0%	39%	22%	33%	6%	28%	17%	28%	17%	11%	5%	21%	26%	16%	32%
Sofa	10%	0%	10%	30%	50%	10%	5%	15%	35%	35%	11%	0%	5%	32%	53%	25%	25%	0%	15%	35%	5%	10%	10%	25%	50%
Office Chair	20%	10%	25%	10%	35%	16%	5%	16%	32%	32%	17%	11%	17%	28%	28%	40%	20%	20%	20%	0%	16%	11%	11%	32%	32%
Bicycle	5%	15%	35%	10%	35%	15%	15%	10%	25%	35%	12%	18%	18%	18%	35%	20%	20%	20%	20%	20%	10%	5%	15%	25%	45%
Headset	15%	15%	15%	35%	20%	20%	10%	30%	30%	10%	15%	20%	15%	40%	10%	25%	30%	15%	20%	10%	15%	15%	15%	40%	15%
Keyboard	11%	0%	16%	37%	37%	5%	10%	20%	25%	40%	17%	0%	6%	44%	33%	10%	10%	30%	20%	30%	5%	10%	15%	40%	30%
Game Controller	10%	10%	30%	25%	25%	10%	10%	25%	35%	20%	15%	20%	15%	35%	15%	16%	21%	26%	32%	5%	5%	20%	10%	40%	25%
Dress Shoes	5%	5%	5%	42%	42%	26%	5%	0%	32%	37%	11%	6%	6%	39%	39%	37%	11%	11%	26%	16%	5%	0%	21%	21%	53%
Backpack	5%	5%	30%	30%	30%	10%	10%	25%	30%	25%	11%	11%	17%	22%	39%	25%	35%	15%	10%	15%	15%	10%	20%	15%	40%
Wireless Mouse	20%	10%	0%	30%	40%	5%	10%	10%	40%	35%	11%	5%	11%	37%	37%	30%	5%	15%	30%	20%	5%	15%	15%	25%	40%
Cluster 2																									
Jacket	15%	20%	10%	25%	30%	15%	20%	15%	25%	25%	20%	10%	10%	30%	30%	20%	40%	10%	20%	10%	15%	15%	15%	20%	35%
Floor Cabinet	5%	30%	15%	30%	20%	15%	25%	5%	30%	25%	5%	16%	26%	16%	37%	20%	40%	10%	15%	15%	5%	25%	15%	15%	40%
Golf Clubs	35%	25%	20%	10%	10%	30%	15%	5%	30%	20%	30%	20%	5%	10%	35%	45%	15%	5%	20%	15%	30%	15%	10%	25%	20%
Kitchen Knife	30%	30%	15%	5%	20%	20%	10%	25%	25%	20%	20%	10%	35%	25%	10%	42%	42%	5%	5%	5%	15%	5%	15%	30%	35%
Water Bottle	20%	25%	20%	10%	25%	25%	10%	10%	35%	20%	16%	5%	26%	32%	21%	45%	20%	30%	5%	0%	20%	10%	20%	15%	35%
Vacuum	30%	25%	30%	5%	10%	10%	20%	35%	10%	25%	30%	25%	15%	20%	10%	20%	25%	25%	20%	10%	25%	15%	15%	25%	20%
Toothbrush	25%	20%	25%	20%	10%	10%	5%	5%	45%	35%	16%	0%	42%	26%	16%	26%	21%	16%	32%	5%	0%	21%	16%	32%	32%
Kayak	15%	20%	15%	40%	10%	10%	15%	20%	35%	20%	16%	21%	21%	26%	16%	30%	35%	15%	10%	10%	10%	15%	25%	25%	25%
Phone Case	15%	10%	20%	25%	30%	10%	15%	25%	30%	20%	32%	5%	37%	11%	16%	35%	25%	20%	10%	10%	20%	5%	20%	10%	45%
Cluster 3																									
Bottle Opener	35%	15%	20%	15%	15%	30%	10%	15%	15%	30%	25%	20%	15%	20%	20%	40%	25%	10%	10%	15%	20%	20%	15%	10%	35%
Vertical Planter	40%	25%	25%	5%	5%	35%	10%	20%	15%	20%	33%	17%	11%	22%	17%	40%	10%	20%	15%	15%	40%	10%	10%	5%	35%
Portable Washing Machine	35%	20%	10%	30%	5%	15%	20%	15%	30%	20%	33%	6%	28%	28%	6%	11%	37%	32%	11%	11%	25%	10%	20%	20%	25%
Table Tennis Table	40%	15%	10%	25%	10%	45%	20%	0%	20%	15%	50%	20%	10%	10%	10%	45%	25%	20%	5%	5%	40%	15%	15%	10%	20%
Lamp	20%	15%	20%	20%	25%	37%	21%	26%	16%	0%	22%	39%	11%	22%	6%	37%	37%	21%	5%	0%	32%	26%	11%	26%	5%
Umbrella	30%	10%	25%	20%	15%	30%	20%	5%	25%	20%	28%	11%	22%	28%	11%	45%	25%	25%	0%	5%	30%	15%	20%	10%	25%

Red fill indicates the percentage of responses are between 0 and 20%

Yellow fill indicates the percentage of responses are between 21% and 40%

Green fill indicates the percentage of responses are greater than 41%

Column sub-headers (repeated for each attribute category): No Interest | Little Interest | Somewhat Interested | Interested | Very Interested

Another important observation from the figure is the existence of three distinct product clusters. In Figure 1. These clusters are labeled cluster 1,2 and 3 and are indicated by the greyscale coloring of the product labels. The existence of these clusters indicates that the products within these clusters share similarity in terms of consumer preferences for their customization. The clusters afford the opportunity to group products together due to their similarity in terms of consumer preferences.

B. Trends Amongst Product Clusters

As described in section II (B), respondents to the survey were asked to evaluate the product attribute categories based on their interest in customizing them. After the collection of consumer responses, the products were organized into the clusters defined in the previous subsection and the results tabulated in Table 1. The percentage of responses to each level of interest are color coded to visually represent the trends amongst the clusters. Based on the color-coding system, a trend would be indicated by the colors for each column lining up within the clusters. In cluster 1, there is a strong trend in the

consumers' preferences. For aesthetics, functional features, form and quality/cost most consumers are either interested or very interested in customizing these attributes. Considering cluster 1 represents the products that were most desirable for customization, it makes sense that most consumers have an interest in customizing features of the product. The interest in customizing the complexity of these products was less uniform. There is a weak trend towards little or no interest in customizing the complexity.

Cluster 2 shows a slight trend in the aesthetics category with most consumers showing no interest in customizing this aspect of the product. There is a strong trend in the responses to customizing the complexity of the product with a large majority of users showing no interest in customizing this aspect. The functional features and the quality/cost categories both show trends towards and interest in customizing these aspects and the form has no discernable trends.

In cluster 3, there is generally a trend towards consumers having little or no interest in customizing the attributes, which is consistent with the characteristics of this cluster that represents the least desirable products for customization. It is notable that there is some interest in all five categories and with the most distinct mix of opinions in the quality/cost category. Considering the strong trend in the other clusters for this category, it highlights the importance of cost to consumers and indicates that offering options to customize the quality/cost of a product is almost always a popular option for customization.

IV. GENERALIZABILITY OF THE DATA

In literature, the collection of consumer preferences using surveys focused on one product. This means that the data collected from those surveys is only relevant to that specific product. Using the methods presented in literature, the design of new products requires new surveys to be conducted. This process can be costly, time consuming and hinders the product development process.

The use of attribute categories in surveys to gather consumer preferences for customization allows the data collected to be generalized to other similar products. Based on the findings of the surveys conducted in this paper, there are clearly three distinct product clusters. These clusters indicate similarities between the products within them. It is reasonable to hypothesize that if this study were extended and the surveys were conducted on other products, the consumer preferences would follow similar trends. That is to say, there would exist clusters and corresponding trends in these clusters in the consumer preferences for customization of the attribute categories.

In the design of new customized products, the data already collected in this study can be used to offer insight into whether the new product should be customized and what kinds of features of the product are desirable for customization. This can be accomplished by matching the new product with one of the clusters identified, then one or more of the products within that cluster. This matching can occur based on product information such as function, usage, or category. For example, company A has a new briefcase they are bringing to market and would like to evaluate the suitability of their product for customization. Based on the survey results, it would fit into cluster 1 because contained within cluster 1 is a backpack. Both the briefcase and the backpack fall into a similar category, that is being a bag. They also have a similar use and function which is to carry items. Since this item falls into cluster 1, the information from the surveys regarding the demand for customizing this type of product and the preferences of attributes desirable for customization can be applied to the design of the new product.

V. CONCLUSION

In this paper, a method of collecting consumer preferences for product customization is presented with a focus on identifying the trends amongst the desires of consumers for customization of products and the customization of product attributes. This work has shown that distinct clusters exist for different products that can be defined by the associated consumer preferences for customization. Specifically, three clusters can be identified based upon the consumer preferences over the three factors of success in customization. By analyzing consumer preferences for the customization of attribute categories, patterns amongst the preferences for customization of these attribute categories can be identified for each cluster. The trends discovered here suggest that the data collected using these surveys can potentially be generalized and used in the design of new products for customization. It can help designers with decision making as to what types of products are appropriate candidates for customization. This methodology improves upon traditional survey-based approaches by using categorical representations of product attributes to allow for the generalization of the data to other products not explicitly included in the surveys.

The surveys conducted here do have a few limitations. The demographics of the respondents are not known. As such it is impossible to determine whether the trends exhibited by the data are dependent on the respondents' demographics. To evaluate the effects of the demographics on the consumer preferences for customization it would be necessary to collect personal information from respondents. The total number of responses collected can also be considered a limitation of the data. Based on the data collected, there is a clear indication that there is a pattern present in the consumer preferences for customization and the pattern presents a method that can help reduce the amount of effort required to gather these preferences. This survey was also limited to a relatively small number of products. The use of more products in the survey could lead to more precise clusters being discovered, improving the generalizability precision of the data.

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