

Introduction and Data Analysis

Humboldt University Berlin conducted a choice-based conjoint study for portable Bluetooth Speakers between December 2017 – February 2018 to get a better understanding of consumer preferences. To determine the relevant attribute and attribute levels for the Choice CBC design, the institute conducted extensive product category research, and interviews with students and young professionals along with performing pre-tests. The survey data analyzed in this study consists of two parts – one is the “choicedata” and other is “indivdata” dataset. The “choicedata” which is the CBC survey including twelve choice tasks each consisting of three alternatives plus a none option. The second dataset is the “indivdata” set which contains respondents’ answers to questions related to the familiarity-knowledge of the product, the stated importance of attributes, and socio-demographic information. Both the data sets were free of missing values and do not contain severe outliers in the socio-demographic variables like age and education as can be seen from Figure 2. We can see that on average a person knows three brands and a maximum of eight brands, indicating that the sample is aware of the market.

Looking at the characteristics of the respondents, it can be seen that the sample is dominated by students (53.50%) and lower-income groups i.e 62% of people are from the lower-income range of less than 1500 euro per month with 79.75% of respondents ranging between 18-29 years. Additionally, the sample primarily consists of people with higher education -undergraduate and graduate (77%). The survey data shows a major focus being laid on students and young professionals, which seems to be justifiable because this group has a greater affinity for technology, innovation, and trends as compared to older populations. The higher-level education is indicative of their capability to understand new technologies. Also, it can be seen that 50.25% of the sample population resides in Germany and has an almost equal distribution of gender.

To get a better understanding of the consumer’s preferences and understanding the relative importance of attributes four features of a Bluetooth speaker are rated on a scale of 0-100, where the attribute “sound” has the highest importance followed by price, battery, and weight in the order.

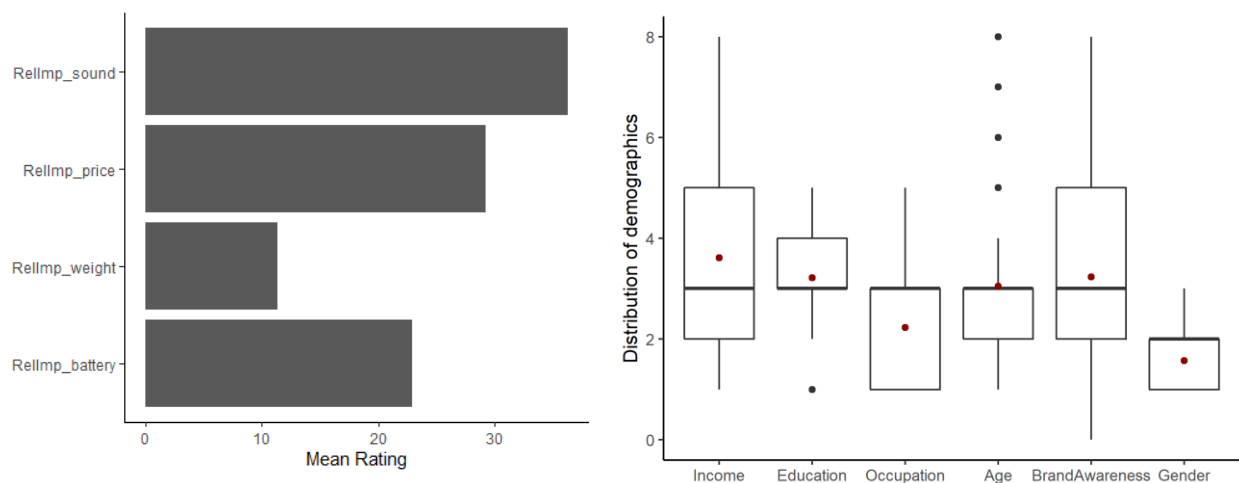


Figure 1(left): Importance rating of attributes across all respondents

Figure 2(right): Boxplots of demographics across the sample population

Accordingly, the Bluetooth speakers should possess high-quality sound output at a reasonable price along with a decent battery backup. The weight of the portable speaker is the least important characteristic. Furthermore, it can be seen that the mean score of all the attributes is below 40, tending to a lower score on the importance scale. This shows that there is a congruence among the sample population to choose low-scale points even for the features that are most important to them. Some important factors that can have an impact on the choice of Bluetooth speakers are the knowledge of the product and familiarity with the product. Both product knowledge and familiarity seem to be associated with the intention to buy and own the product. The questionnaire has a 5-item subjective knowledge scale and a 5-item Product category involvement scale to measure knowledge and familiarity with Bluetooth speakers respectively. Generating the factor scores for both these features for all the respondents we saw that people who have high higher knowledge and more familiarity (product involvement) with portable Bluetooth speakers are highly likely to own a portable Bluetooth speaker or have an intention to purchase one as compared to those who have less subjective knowledge and product familiarity (figure 5 and figure 6). This does make sense, as people who do not have the intention to purchase the product are usually indifferent to gain any knowledge or familiarity of the product. Similarly, people who own the product use it regularly and therefore tend to have more expertise with the product as compared to someone who doesn't own it. Also, the brand awareness is almost the same in whether people own a Bluetooth speaker or not and whether they would want to buy one or not. Interestingly, one can see that females have less subjective knowledge, product involvement, and brand awareness related to Bluetooth speakers as compared to males.

On further analysis of choice data which contains the CBC choice tasks, we can see that the mean value of linear coded attributes of Bluetooth speaker like sound (3.19 stars), battery (9 hours), weight (412.70g), and price (82.49 euros) shows proclivity towards lower values. Although there is no certain pattern to be seen between willingness to pay and income range, people seem to be price-sensitive and hence are willing to compromise with the attributes like sound and battery. The tradeoff between price and attributes of Bluetooth speakers is evident from the correlation as seen in Figure 3. An increase in the importance of price results in a decrease in the importance of sound, battery, and weight. This is coherent with our findings that high price sensitivity (as seen by the lower mean value of the price) results in compromising with the higher attribute levels. The low willingness to pay for the product may be due to the reason that our sample is dominated by students and young professionals who are in the lower-income ranges and might not want to spend money on an item that is not essentially a commodity.

Respondents chose a Bluetooth speaker at the 70 Euro and 90 euros price point much more often than they chose speakers priced at \$130 or 150. Additionally, one can see that people prefer high battery backups like 14 and 16 hours as compared to 8 hours. Similarly, there is an imbalance in counts for sound and weight, where people prefer a higher star sound level like 5-star and lower speaker weight of 400g and 500g. This imbalance suggests that all the attributes are important for preference measurement.

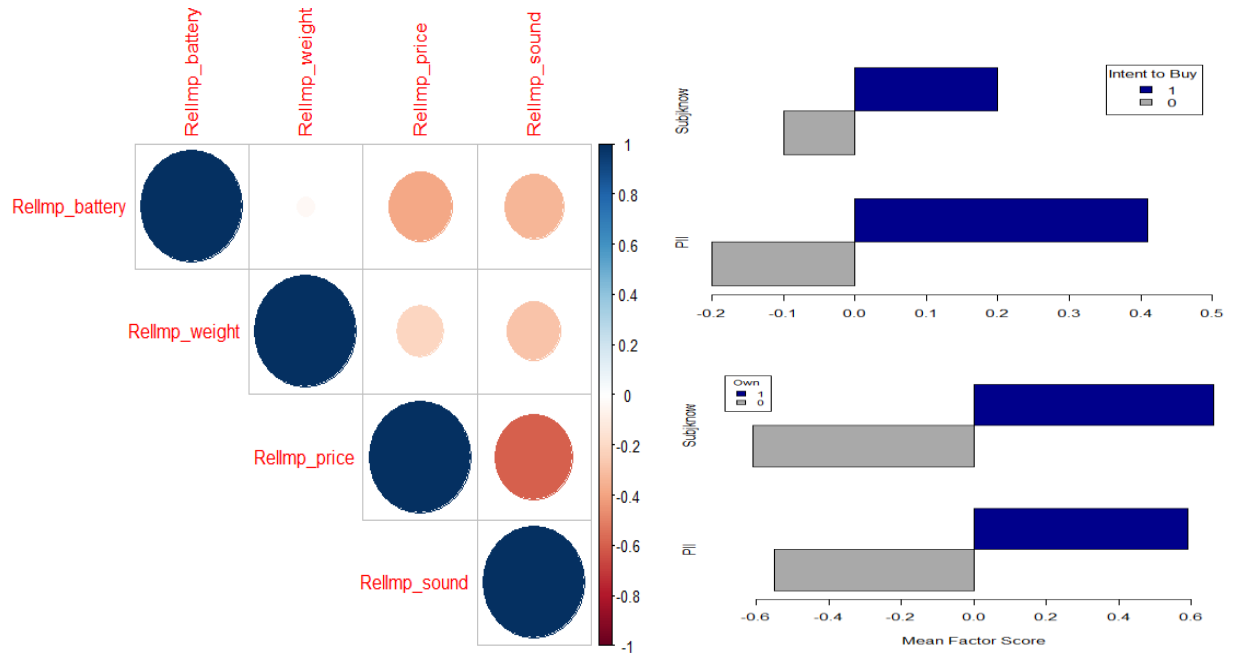


Figure 3(left): Correlation between the stated relative importance of product attributes and price

Figure 4(top-right): Association of Intent to buy with Product Involvement (PII) and Subjective Knowledge

Figure 5(bottom-right): Association of owning a Bluetooth speaker with Product Involvement (PII) and Subjective Knowledge

Customer Segmentation based on consumer preferences

Having a general overview of data from the initial data analysis reveals the consumer preferences in terms of absolute attribute values but it's important to understand the utility a consumer draws from an attribute (specifically from attribute level) while choosing between products.

The objective is to decompose the total evaluation into component scores, imputable to each attribute level or combination of attribute levels. Therefore, we further analyze the choice data to address the question of preference measurement which would lead to a purchase decision. We will be using one of the most popular methods within preference measurement which is conjoint analysis.

Multinomial logit model

The multinomial logit model estimates a single set of part-worth coefficients for the whole sample. The attributes of Bluetooth speakers taken into consideration in our study are price, battery, weight, and sound. The socio-demographic variables like Income, Education, Age, and Occupation can be seen to have very a skewed distribution with some categories having as low as 7% of the total sample population, which makes them unsuitable for interactions effects with features of Bluetooth speakers. Looking at gender, intention to buy, product involvement, and subjective knowledge we see that they have a uniform distribution of data points among categories, but doesn't have a significant correlation with the stated relative importance of product features (sound, weight, price, and battery), so this deems them as unimportant candidates for an interaction effect in CBC model. The three MNL models that can be developed for a better understanding of attribute coding are as follows:

1. Model 1: Main effect model with Linear price coding and dummy coding other attributes where the base level of attribute's part-worth is assumed to be zero
2. Model2: Main effect model with Linear price coding and effect coding other attributes
3. Model 3: Main effect model with mean-centered linear price coding and effect coding other attributes

All the models performed the same on the Likelihood ratio test (-4597.54) and also the same on the model selection criteria like AIC(9219.08) and BIC (9296.80). The coefficients for all the attribute levels is the same for model 2 and 3, so the ranges calculated from both the models are also the same. Looking at the relative importance of the attributes obtained from both models, price is the most important preference criteria, followed by sound, battery, and weight in order. Also, it was evident that people had a higher willingness to pay for a speaker which has a 16-hour backup, 5-star sound quality, or 400g weight. It shows people are willing to pay for better attribute levels.

Mixed Logit Models

In the previous MNL model, we assumed the preferences to be the same across individuals. Although in the real-world different people have different preferences and models that estimate individual-level coefficients can fit data better and make more accurate predictions than sample-level models. Therefore, this study prefers mixed logit model to add heterogeneity to our choice model. This will incorporate the random preference variations, usually those which are unobserved by the researcher. The limitations of MNL are addressed in the mixed logit model by allowing the coefficients in the model to vary across individuals (i.e., allow for unobserved preference heterogeneity). We will again choose to show no interaction effects of population characteristics with product features in our CBC model due to the reasons discussed in the MNL model. For mixed logit, we chose to work with price, sound, battery, weight, and their corresponding levels.

This study focuses on the following aspects of the mixed logit model:

1. Main effects model with linear price effect and part-worth model (using effect-coding) for other attributes
2. Assuming a diagonal covariance matrix
3. Assuming all preference parameters are normally distributed.
4. The number of draws $R = 200, 600$. Higher R may lead to better precision but comes at a cost of higher estimation time, so the number of draws was kept relatively low.

In this paper we will proceed with 600 draws as the Log-likelihood of the model with 600 draws is slightly better than 200 draws. We looked at two estimation methods namely individual-level estimates and population-level estimates. Individual-level estimates helped in understanding the preference estimate of the people who took part in the study and to see the preference study of the sample at hand. On the other hand, population-level estimates helped to see if the preference estimate represents the general taste of the population. From Figures 6 and 7 it can be seen that price is given higher importance than sound in population-level estimates whereas sound is given slightly greater importance than the price in individual-level estimates. This shows that the stated measures are similar to the estimated relative importance of attributes for population-level and

slightly different from the estimated relative importance for individual-level estimates. However, there is much similarity in the relative importance of attributes for both individual and population-level estimates. Additionally, one can see that in both population and Individual-level estimates, there exist exactly four patterns based on individual differences in terms of the highest importance assigned to an attribute.

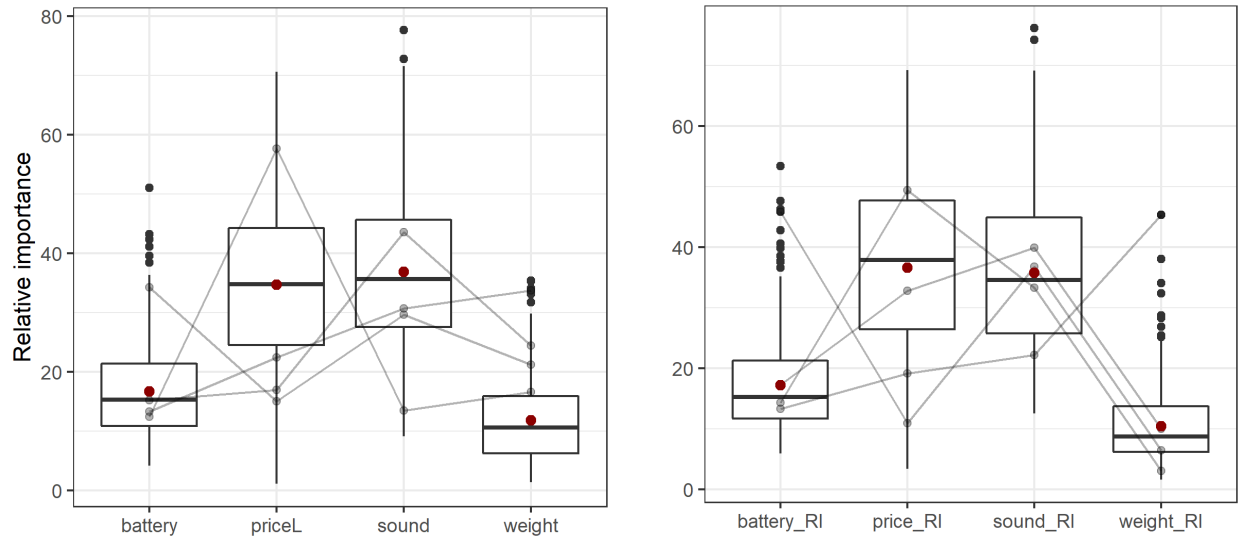


Figure 6(left): Relative importance of attributes based on population-level estimates

Figure 7(right): Relative importance of attributes based on Individual-level estimates

Furthermore, for the analysis of Willingness-to-pay, one can decide to remove the coefficients of the price which are positive because as per assumption people are price-sensitive, so one expects the price coefficient to be negative. Keeping the value of the price coefficient to be negative removes fifteen and sixteen observations from population-level and individual estimates respectively. Moreover, it is observed that Willingness-to-pay has severe outliers, identified based on the inter-quartile range (IQR). Corresponding outliers are truncated and set to a constant value equal to the IQR times a factor, which, following Tuckey's rule, is set to 1.5 by default. One can decide not to remove the outliers but to adjust them to a constant value based on IQR to understand the pattern of outliers, which is what is done in this report. The investigation of Willingness-to-pay distribution for both the estimates reveals the same pattern where people are preferring to pay high for better features.

- Individual-level estimates

- a. Battery- For the battery feature taking 8 hours battery as the reference level one can see that for 10 hours battery has a very small share of the population that would dislike it and would prefer 8 hours battery. As for 12,14, and 16-hours battery the distribution spans in only one direction. People are willing to pay up to 60 euros for a 12 and 14-hour battery speaker and up to 80 euros for a 16-hour battery. Additionally, a small portion might also like to pay as high as 120 euro for 12,14, and 16 hour battery.
- b. Sound: Taking sound_4s as the base level, it is observed that people dislike the sound 3-star level and prefer sound 4-star level. As for sound levels 4.5 and 5-star,

people are willing to pay up to 80 Euros more than they would pay for a sound 4-star Bluetooth speaker, with some even willing to pay as high as 120 euro.

- c. Weight: With reference to 700 gm of Bluetooth speaker, it can be seen that majority people would be willing to pay up to 40 Euros more for 400 gm and 500 gm, with some people even willing to pay more than 80 euros for the same. As for 600 gm, it can be seen that although the majority is preferring to pay up to 40 euros there is a small share of the population that would pay 10 euros more for 700gm.
- Population level-estimates
 - a. With reference to the 8-hours battery, people are willing to pay up to 100 euros more for the 10,12,14, and 16-hours battery levels.
 - b. Sound: Taking the 4-star sound as the base, it is seen that people would pay 50 euros less for 3.5-star sound Bluetooth speakers. It is also evident that people would pay up to 100 euros more for 4.5-star and 5-star sound as compared to 4-star sound.
 - c. Weight: Here the base level is 700 gm. One can see that 400gm,500gm, and 600gm spans in both directions. Although the majority of people would pay up to 100 euros for low battery weight, some people would pay 50 euros for a heavier speaker(700gm).

Forming Segments with Conjoint Results

Our data set consists of background questions on the respondents including the socio-demographic, relative measure of attribute importance, and product familiarity related variables. Additionally, the conjoint analysis usually yields part-worth functions (and therefore importances) for each attribute in the design at the Individual-level. These data (part-worth, importances, utility in monetary terms, and willingness to pay) along with the background variables form the basis for segmentation.

For segmentation, the individual-level estimates are taken into account since they reflect the choices of the sample respondents for whom the background variables have been collated. From the analysis, it was discovered that the scale-independent measures obtained from conjoint analysis i.e. relative importance of attributes, utility in monetary terms, and willingness to pay are the optimal choice for being used as predictor variables in cluster analysis.

Looking at the elbow plot of the number of clusters vs Variance Ratio Criterion, there is a big dip from 2 to 3 clusters segued by 4, 5, and 6-cluster solution. However, it is a plausible decision to choose a 3-cluster solution because it gives clear, and non-overlapping customer segments. Also, the proximity measure chosen is the Euclidean distance since all the scale-independent measures are continuous variables. Additionally, we chose to work with a hierarchical clustering algorithm because it will be efficient for the machine, and would generate a dendrogram. The wards method was a sound choice in our scenario as it was the only hierarchical clustering method that did not produce a chaining effect, and was insusceptible to the outliers.

Cluster description

The socio-demographic variables do not show significant differences in the 3-cluster solution. This can be because our survey dataset was dominated by students between the ages of 25-29 years, and in the lower-income range of fewer than 1500 Euros per month. This is the mean demographics

in all three clusters. The clusters are mostly distinct based on their attribute, and attribute level preferences.

Followers: This is cluster 1, as can be seen from Table 1. This segment is the second-largest cluster (29.44% of the population), with a medium willingness to pay for all attribute levels. The willingness to pay for this cluster lies between the extremities of the other two clusters. This is the only group whose male population (74) is almost twice that of the female population (41), whereas in the other two clusters the male and female distribution is almost equal. Apart from this, the group owns the highest percentage of Bluetooth speakers (57%) and has a high intention to buy also (37%) (Table 1). However, this group has medium involvement with the product and has medium knowledge about it. The high intent to buy and ownership of speakers but relatively low familiarity and involvement with the product indicates that they maybe follow the prestige-trend associated with the Bluetooth speakers. Since the sample data is dominated by students, it might be the tendency of some to purchase items that have hype in the market but they are not particularly into them. That is why this cluster can be named as followers, following our assumption that they follow current market hypes for establishing their class in society by keeping up-to-date with the latest technological innovations. The order of attributes based on stated and estimated Relative Importance is the same with sound being the most important feature in decision making for this segment. Based on the relatively good size, high willingness to pay, and high intention to buy, this segment can be rated 6 on a scale of 7 for market attractiveness. Assuming that this segment has an online presence on social media channels, it can be attracted using discounted pricing, with campaigns like connecting with the community in terms of being trendy.

Afficionados: This is cluster 2 (Table 1). This is the smallest segment with only 11.93% of the sample population. This segment can essentially be characterized by its lowest price sensitivity among all the groups. Price is the least important feature for this segment with sound being the most important one in decision making. This segment shows a tendency to pay comparatively high, for all the product attribute levels. 55% of them own a Bluetooth speaker and 37% of them intend to purchase one (table 1). Additionally, they have high product involvement (0.35) and Subjective Knowledge (0.48) (table 1). This group seems like a real fan of Bluetooth speakers and they don't shy to pay higher prices for the best attribute levels. If this segment would have had a decent market size then this would have been the highest-rated group among all three with regards to market attractiveness. But given the fact, that it's a small segment with high affinity and willingness to pay for the product, it can be rated a 5 out of 7 for market attractiveness. There can be seen some difference in the stated and estimated relative importance (RI) for this group with price being the least important in estimated RI and weight being the least important in stated RI. This also shows the significance of performing discrete choice modeling which ensures the simulation of real-life choices.

Laggards: This is cluster numbered as 3, as one can see from table 1. This is the largest customer with 58.63% of sample respondents. Looking at both the stated and estimated RI, it is evident that this segment is highest on price sensitivity, the sound is the second most important feature, followed by battery and weight. This group owns the least Bluetooth speakers (42%) and is least interested in buying it (29%)(Table 1). Moreover, this group has the least knowledge about Bluetooth speakers (-0.20) along with being least involved with its attributes (-0.16) (table 1). This segment has high potential given its market size and low propensity for the product. It seems like

the expected behavior given that the majority of the sample consists of students and young professionals, who are early in their careers are more inclined towards saving money rather than on spending on technological innovations. This segment possesses characteristics that reflect that these individuals are the last to adopt an innovation. For market attractiveness, this segment can be given a 4 on a 7-point scale, specifically because of its market share. Having 60% of the market share this segment cannot be left out of marketing and promotional activities. The competitors may offer differentiated prices in the market or position the product with a focus on the utility of Bluetooth speakers rather than a trend or prestige. Maybe workplace applications of Bluetooth speakers can be highlighted in campaigns, especially in current times of a pandemic when the whole setup of work and studies has shifted to one's home. Bluetooth speakers like Alexa can help avoid the chances of missing important work or study-related notifications, in networking and file sharing. Maybe campaigns that are more focused on the utility of Bluetooth speakers will help in attracting this market segment.

The segments that should be targeted for acquiring new customers at the lowest possible cost are "Followers" and "Aficionados", because of their high propensity towards Bluetooth speakers and willingness to pay a medium to high price for the same. Also, together both of them make up more than 40% of the population which is significant market size. Offering these segments products which are high on sound technology innovation, durability, portability, and flexibility will be major factors in attracting both these segments. Since both do not price-sensitive, huge profits can be generated from them and a price of around 120 Euros for the Bluetooth speaker with best attribute levels like 16-hour battery, 5 star sound and 400 gm weight of Bluetooth speaker or a medium price range of 110 Euros for a feature like 10-hour battery, 4 star sound and 600 gm of Bluetooth speaker.

	WTP												
	battery					sound				weight			
	16h	8h	12h	14h	10h	4s	3.5s	5.0s	4.5s	500g	400g	600g	700g
1	47.7	0	37.7	45	21.59	0	-28.23	72.73	39.9	21.5	29.14	11.09	0
2	77.47	0	77.8	84.5	54.73	0	-20.48	71.49	76.21	61	72.77	41.75	0
3	27.44	0	21.1	24.9	12.38	0	-22.55	25.94	18.33	11.75	15.61	6.07	0

	Own	Intent To Buy	BA*	PII*	SK*	Stated RI				Estimated RI			
						battery	weight	price	sound	battery	price	sound	weight
1	0.57	0.37	3.5	0.17	0.19	21.8	12.01	21.78	44.39	16.67	26.33	46.74	10.26
2	0.55	0.38	3.3	0.35	0.48	30.8	12.79	17.17	39.23	25.17	14.31	43.14	17.38
3	0.42	0.29	3.1	-0.16	-0.2	21.7	10.65	35.83	31.8	15.85	46.28	28.78	9.1

Table 1: Cluster description of segments obtained from conjoint results

* BA – Brand Awareness, PII – Product category involvement, SK – Subjective Knowledge

Market Simulation

To understand competition in the Bluetooth speaker market, generate profit-maximizing pricing strategies and for decision-making for product-line extensions, we consider two scenarios in this study. For both the scenarios we use effect-coding the attribute levels for each product and use individual-level estimates. The market structure assumed in both scenarios is as follows:

Scenario 1: Two firms are offering one product each on the market:

Firm 1:- product 1: Sound quality of 5.0 stars, the weight of 600grams, battery life of 12 hours

Firm 2:- product 2: Sound quality of 4.0 stars, the weight of 400grams, battery life of 16 hours

In scenario 1, we aim to determine the price that will generate maximum profits for each firm. We call the profit-maximizing price the optimal price in this report. Considering the marginal cost for firm 1 and 2 to be 75 and 70 euros respectively. One can try to achieve optimal price by fixing the initial optimal price of one firm, suppose firm 1, and obtaining the price of firm 2. Based on the price set by firm 2, firm 1 might react by making changes in its pricing strategy. Firms will continue reacting to each other until they both get to a point where changing the price doesn't make sense. This point of convergence is called Nash's equilibrium.

Keeping the initial price of product 1 at 75 Euro, i.e. equal to the marginal cost incurred by the firm. The price is set equal to the minimum cost so that the firm can at least retrieve the cost incurred by it. By setting the initial price by the firm to 75 euros, the optimal price achieved by firms 1 and 2 is 113 and 97 euros respectively. The market share of firms 1 and 2 is 50% and 38.75% respectively. The profit of Firm 1 (7600 Euros) is higher than Firm 2 (4185 Euros), given the high market share and price of Firm 1.

This result is justifiable as firm 1 offers a product with a better sound quality of 5.0 stars as compared to 4.0 stars by firm 2. Although the weight and battery of the product offered by firm 2 are better than what is offered by firm 1, it does not have a high impact on the decision-making of the consumer, which is evident from the market shares of each firm. As we have seen in the analysis of the mixed logit model of individual-level estimates, the sound is given higher importance than battery and weight by the overall sample in purchasing decisions. Therefore, the better sound quality by firm 1 is given higher preference and so it has a higher market share.

Since Firm 1 offers a better quality sound system, so this is penalized by pricing the product at 16 euros more than firm 2, but the price of 113 euros is also a judicious price given the price sensitivity of the sample. Also, from the segmentation analysis earlier we saw that every segment was having positive willingness to pay for the best attribute levels. In the analysis of different groups, it was decided on keeping a price of 120 euro for a product with the best attribute levels. Since firm 1 offers the best sound attribute (5.0 stars) and average weight and battery, the price of 113 euros is justifiable.

Scenario 2: Two firms are offering three Bluetooth speakers on the market:

Firm 1, product 1: Sound quality of 5.0 stars, weight of 600grams, battery life of 12 hours

Firm 1, product 2: Sound quality of 5.0 stars, weight of 600grams, battery life of 16 hours

Firm 2, product 3: Sound quality of 4.0 stars, weight of 400grams, battery life of 16 hours

For scenario 2, we can use the optimal prices obtained from scenario 1 i.e. 113 and 97 as the initial prices in euros for products 1 and 3 from firm 1 and firm 2 respectively. They can be used to obtain the price for the new product from firm 1. It can be seen that the price for product 2 is set at 90 euros, with a market share of 30% (figure 7). The price of product 1 increases by just 1 euro, with a 4.5% increase in market share (52.25%). The overall profits from products 1 and 2 led to a 30.93% increase in the overall profits of firm 1 (9951 Euro profit from products 1 and 2).

Additionally, one can see the market share of product 3 by firm 2 has a significant drop from 38.75% to 5.50%, with a 76.87% decrease in profits (from 4185 to 968 euros). The introduction of this new product by firm 1 will prove to generate profits for it along with capturing a higher market share. Moreover, it would provide a competitive edge over the product offerings of firm 2 because it is offering a better-quality product at a lower price since it is not seen often in the market. In our early findings, it is seen that attribute sound has a higher preference over the weight and battery. This finding is reflective in the market simulation where both Bluetooth speaker products of firm 1 gain higher market traction because of the best sound quality level offered (5.0 star) as compared to 4.0 star offered by firm 2. Since product 2 is providing better battery backup, it should have had higher shares than product 1 given that higher attribute battery is of high importance to customers as than weight. But still being new to the market, product 2 has gained a major portion of the market. Also, the price is reasonable for the cost-sensitive student population which took part in our study. It would therefore be advantageous for firm 1 to launch product 2 in the market, because of the competitive advantage in the market, profit generation by the new product, and higher market share captured by the firm. This would also improve the brand's awareness and might help create its image as an innovative and affordable brand.

From Figures 7 and 8 it can be seen that the market share and profit of product 2 will decrease on increasing the price. Thereby, increasing the market share and profit for products 1 and 3. This shows that keeping the price of product 2 at 90 euros would be a beneficial option for firm 1.

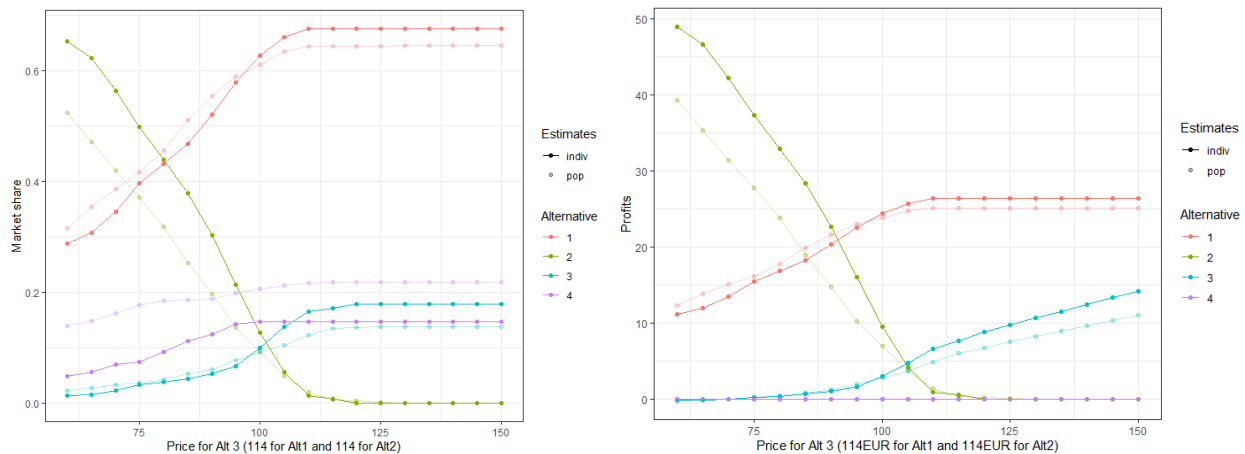


Figure 7(left): Changes in market shares due to price adjustments in product 2 by firm 1

Figure 8(right): Changes in profits due to price adjustments in product 2 by firm 1

Conclusion and Limitations:

In this study one was able to understand the consumer preferences based on the real-life choices. It can be seen that people prefer to purchase better quality products and are also willing to pay for higher quality products. One of the limitations of this study was that the dataset was dominated by students and young professionals in lower income and lower age range. This study can be extended to understand the preferences of a higher income and higher age group population also.