

10 The Letter to the Marketing Director of Sunshine Company

Dear director,

Considering today's increasingly fierce competition in e-commerce, accurately grasping customer needs and specifying appropriate marketing strategies are of vital importance to improve corporate profits and product visibility. As response to your company's requirement, we are here pretty glad to have the opportunity to introduce our research and suggestions to you, with the hope that it may give you some insights of the future strategies.

1. Pay attention to and properly guide the early reviews.

Throughout the whole records of consumers' ratings and reviews for hair dryer, microwave and pacifiers, we find the the averaged number of helpful votes for a single review in the first 5 stage is above 3.2 times than that in recent period. Moreover, the descriptions in some reviews with rate 2 look even worser than that with rate 1, and so are descriptions in reviews with rate 4,5. Since helpful votes and the fitness of review description associate tightly with people's belief and the reputation propagation of products, we suggest Sunshine to properly guide and closely track the trend of early reviews, e.g. make guidelines of which rate corresponds to which extent of attitude, so as to smoothly go through the cold start stage.

2. Keep a good image of brand for all three products.

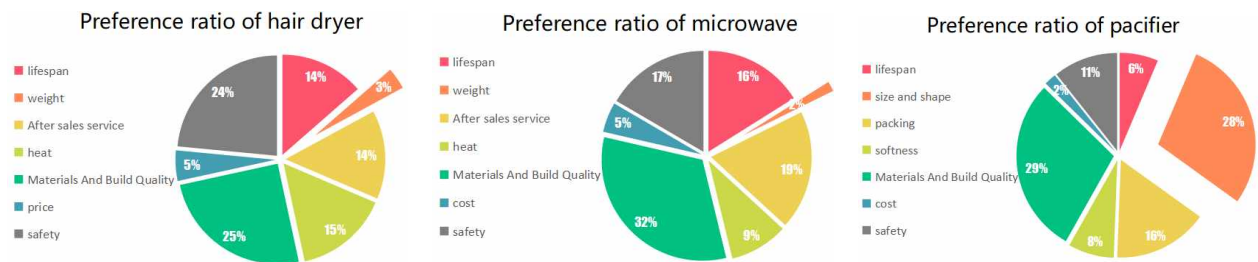
Based on our statistics, the number of reviews has increased rapidly in recent years, which reflects the great prospects of the online sales market. Whereas at the same time, it should be noted that the star rating and averaged review length will experience large fluctuations in the early stage of the product launch. This phenomena may give customers a bad or fuzzy brand impression. Moreover as the data shows, the early review volume, an indirected reflection of brand popularity, has been hovering at a lower level. As a result, if Sunshine can perform well, e.g. keep a good image of brand, in the early stage, great chances are that it will take a lead in such a highly competitive market, which may exert continuously positive effects on your subsequent development.

3. Apply our reputation index to monitor product dynamics.

Since the review and rating data is rich and complex, refining a comprehensive indicator that summarizes product reputation and sales is necessary for Sunshine to quickly adjust its promotion strategy. In our project, we design a reputation index which takes into account the star rating, time gap of adjacent reviews, review helpfulness rate and readability, information of vine and verification. The time-varying coefficients of joint contribution are calculated by LSTM, whose losses on testing dataset are small enough to be emphasized. Note that the time gap of neighboring reviews is a reflection of product popularity and we assume it to be proportional to the sales volumn, hence our reputation metric can be a great indicator of not only people's attitude towards products but Sunshine's profits.

4. Attach different importance to products' properties according to people's preferences.

Trough the text mining of LDA topic model, we extract 7 topics for each product, which represent the product properties that customers care about most. By an integrative consideration of reviews' keywords, ratings, helpful votes and the time decay of ratings, we estimate customers' preference vectors in 8 topics for each products, i.e.



As can be seen from the figures above, except for the tight control of products' materials quality, we suggest that your company ensure the security, heat and after sales service of hair dryer and microwave, as well as the size, shape and packing of pacifier.

We are really appreciated for this opportunity to assist you in building up an online marketing strategy, and we are convinced that our proposal can be utilized in improvement of your competence for the three products. Please feel free to contact us for further information on the project.

Sincerely yours

MCM 2020 Team

Dear Marketing Director of Sunshine Company,

According to your requirements, we analyze the ratings and reviews of competitive products on Amazon for baby pacifier, microwave and hair dryer to be introduced and sold by your company. We form three models dubbed as Informative Evaluation Model to assess the amount of information of each review, Difference Equation Based Model to formulate the change of product's reputation and Time Series Forecasting Based Evaluation Model to predict potential success or failure of the product. And we get some meaningful results, which contribute to attract consumers and develop adaptable online sales strategies.

First of all, We construct the Informative Evaluation Model to help you track informative reviews and ratings conveniently. This model can assess whether each review is informative based on star rating, review text, and helpful votes, then rank the reviews based on the amount of information. We believe this informative evaluation is critical to your work when handling a large amount of review information, for informative reviews often provide more constructive input into the design features and therefore are more referential in reputation analysis.

We get consumer's preferences and concerns by sifting through the top 1% most informative ratings and reviews of baby pacifier, microwave and hair dryer. The popular design features by our analysis are as follows:

- Baby pacifier: Various alternatives to size and safe materials are necessary. Besides, cute patterns are popular with babies.
- Microwaves: Multifunctional microwaves with rotating grills, accurate timers, multiple usage patterns, etc. are welcomed by consumers.
- Hair dryer: Consumers prefer hair dryers small with high-power (on the premise of safety). Some additional designs like folding handle are beneficial to attracting consumers.

Then we establish time-based measures to predict the increase or decrease of product reputation in the online marketplace. Our model can accurately predict the reputation change of a product over a long period of time in the future. This precise prediction makes sense for you to generate strategies before the decrease of the reputation.

Based on the reputation prediction, we stipulate that the degree to which reputation will increase or decrease in the future as judgment of the potential success or failure of the product. Our analysis shows that, overall, baby pacifiers are potentially successful products, while microwaves and hair dryers are at greater risk of failure.

According to our analysis results, we formulate reasonable sales strategies for your company: (1) We recommend that you put microwaves and hair dryers into the market when the reputation rises. While the reputation of baby pacifiers is on the rise, and it's best to put them on the market now. (2) The more complete the product information is, the less loss will be caused by the unequal information between buyers and sellers. (3) We recommend that you increase your promotional efforts when there are more five-star ratings of your products to form positive feedback. (4) When your product's reputation declines, focus on one-star ratings and reviews.

Thanks for taking the time out of your busy schedule to read my letter. Hope our advice can help.

MCM Team # 2002116

10 Our Letter

From: Team #2004647

To: Marketing Director of Sunshine Company

Date: March 9, 2020

Dear Marketing Director of Sunshine Company,

Thank you for hiring us as your consultants! We are informed of your specified requirements and have fully evaluated the feasibility of our tasks. Here we present to you with our detailed solutions.

We thoroughly examined the data of reviews and ratings associated with our competitors' products. We discovered that a lot of the attributes of the data can be utilized, along with the actual rating levels and review contents, to figure out an fairly informative measure for you to track. To perform quantification on them, we proposed the Rating and Review Based Score Model, which introduces our defined data measure—*score*. In our model, a product's score describes customers' responses to the product. It is based on both ratings and text reviews. When calculating the score of a product, we take into account of:

- Its received rating levels;
- Whether its reviews are from Vine reviewers;
- The sentiment intensity of the review contents (as "fair" is less intense than "wonderful", with both being positive words);
- Whether its reviews are from verified buyers;
- The helpness-ratings of its reviews, which help filtering out reviews that are already *unhelpful* to other customers;
- The lengths of its reviews.

By combining these factors altogether, our measure should be able to pick out the most valuable ones among all kinds of voices, which your company should attach great importance to once your products are launched—because they contain crucial information for you to know what problems your products have and how you can improve.

Based on our *score* measure, we further proposed the Reputation Model, which straightforwardly defines the *reputation* of a product—which is a time-based measure for quantifying a product's reputations among customers over time periods. The measure was proved to be fairly accurate in terms of describing a product's actual (but abstract) reputation, supported by the strong correlation between trends of the quantified reputations and the product's sales.

Empirical knowledge suggests the successfulness of a product is closely connected to its sales. Since we know our reputation measure is reliable and strongly correlated with the product's sales, we can utilize it to indicate a product's future successfulness. We approached this by adopting Gaussian Process Regression, and it turns out we can finely predict a product's reputations in the near future based on time series of its calculated reputations. Therefore, we are able to predict a product's potential success or failure in the future in the short term; though it lacks in accuracy when making long-term predictions.

As for the specific questions you are concerned about, we sought to find out whether a series of specific ratings can incite some type of reviews. By recording customers' reviews right

after a series of same ratings, by calculating the chance of them being either positive, negative or neutral, we managed to find out that a series of high ratings do incite more positive reviews—which indicates a significant reputational increase. However, due to lack of evidence, we cannot determine for sure whether a series of low ratings incite negative reviews.

To address the other question that whether specific quality descriptors are strongly associated with rating levels, we first obtained a word set of 2,477 words, all of which are graded by its sentiment intensity (say "wonderful" is more positively intense than "fair"). Then we match all of the review contents in the provided data and calculate words' appearance and associated rating levels. The results reveal noticeably strong connections between them. For example, of all the reviews that contain the word "awesome" (which has a maximum of positiveness intensity), 86.96% of them are associated with a 5-star rating. On the other hand, of all the reviews that contain "dangerous" (which has a maximum of negativeness intensity), 63.46% of them are associated with a 1-star rating.

Finally, with our modeling and methodology, we have devised a set of marketing strategies you can adopt, and a set of design features for each product that customers value the most. We first performed weighted average of all product models' reputations in each market, which are weighted by the products' sales, and thus we have a measure for the potential competition that your company will encounter, for average reputations in a market can indicate the market's customer loyalty. The results reveal that it takes the most effort to compete in the pacifier market and the least in the microwave market. Therefore, we present following marketing strategies:

- If your company has enough effort to spare, we suggest you put more effort in selling pacifiers, *e.g.*, allocating more of your advertising budget to your pacifier;
- If your company does not have enough effort to spare (due to shorthanded-ness or limited budget), we suggest you put more of your limited effort in selling microwaves, for you can pursue superiority in at least one market;
- No matter what, your company should constantly track our *score* and *reputation* measure of your products, for they can finely reflect customers' opinion on the products.

Subsequently, we matched the reviews with quality specifying nouns and calculated their appearance. Then we picked 3 words with most appearance for each product, which indicate design features customers value the most. The results show that customers expect a reasonable price for all three types of products. While specifically:

- Customers might want a hair dryer to be able to produce enough heat and to have a high-quality cord;
- Microwaves are expected to have a sufficient space and customer service is also valued since machines can break down any second;
- Pacifiers are for babies, reasonably parents expect them to have a good quality and appropriate size so that babies feel comfortable biting on it.

If you want to know more details, please refer to our thesis. We will be glad to discuss with you on our solution details.

9 A Letter to the Marketing Director of Sunshine Company

To: The marketing director of Sunshine Company

From: Team # 2007707 of 2020 MCM

Date: March 9, 2020

Subject: Findings on Sales and Design Strategies of New Products

Dear Sir or Madam:

It is our great honor to be employed as your sales consultants to provide sales and design strategies for your new products (the microwave oven, baby pacifier, and hair dryer). Based on the star-ratings and reviews in the provided data files, we build mathematical models to identify their changing patterns over time, and devise a simply, convenient, and practical business tracking system for you. Our approaches, findings, and suggestions are as follows.

First, we conduct statistical analysis of the review data, including the star-ratings, favorable rate, number of reviews, number of words in reviews, and number of favorable reviews of the three products in each quarter. To accurately analyze the sentiment degree expressed in the text-based reviews, we use advanced models to extract their keywords, and calculate the sentiment value. Also, we build a model to figure out the changing patterns of an indicator while changing time and other indicators. Finally, we put forward the success index to track the future product operating conditions, and verify its effectiveness.

Here are some findings based on our results.

- During the past few years, the number of reviews and their contained number of words were constantly increasing and decreasing, respectively. As for star-ratings, favorable rate, and positive sentiment value, they ascended initially and reached the plateau afterwards. However, if we only focus on reviews with helpfulness votes, the overall reputation of the three products were continually declining.
- The interaction degree between star-ratings and reviews is limited. Customers will make more negative reviews after they read a series of reviews with low star-ratings, but high star-ratings cannot increase their positive sentiment. Also, favorable reviews usually correspond to high star-ratings, but negative reviews are not associated with a specific star-rating level.
- Among the review keywords of the three products, emotional words rank the first, followed by descriptive adjectives and features words of products. In other words, buyers prefer to express their feelings after using the product in the reviews, and then describe the product.
- Among the keywords of hair dryers, words related to power, weight, and portability are most important. As for pacifiers, customers focus on their shape, material and safety. In terms of microwaves, customers pay more attention to their installation, size, and after-sales service.
- If the star-ratings, favorable rate, or review sentiment value in a quarter are too high, they are very likely to decrease sharply in the next quarter. Also, the higher they are in this

quarter, the more sharply they will decrease in the next quarter. Nevertheless, the higher the star-ratings, the less the number of words in reviews will reduce in the next quarter. Moreover, the number of reviews is not related to other indicators.

- The success index we define effectively distinguishes between the top 50% and the bottom 50% products. It is a valid business evaluation indicator for companies.

Based on these findings, we put forward some sales and design strategies as follows.

- Do not pursue 100% high star-ratings blindly, because this will not help with future reputation. Instead, they might leave a bad impression of "deliberately clicking farming" on customers, or give them too high product expectations. You only need to ensure that the average star-ratings of the product maintain at a normal level, and the reputation of the product will rank the top among other competing products in the future.
- Ensure that the yield rate of each quarter is basically the same without a reduction in the product quality in a certain quarter, because a series of low star-ratings will result in increase in negative sentiment and decrease in purchase desire.
- Since people pay more attention to the reviews with more helpful votes published by reviewers with vine, you had better increase their star-ratings and positiveness. You can keep an eye on these trustworthy and helpful reviews of other competing products and improve them on the issues mentioned in those reviews.
- As for pacifiers, you can focus on the cuteness of the shape, i.e., some animals such as cats and elephants are popular. Moreover, you should ensure that the pacifiers are made of soft materials, and their production process is hygienic and safe, because the buyers are usually parents, and they pay more attention to whether the pacifier is suitable and safe for baby teething.
- In terms of microwaves, since they update at a low speed, you can concentrate on other aspects, i.e., installation convenience, and suitable size. Additionally, customers particularly want microwaves to be repaired in time, so it would be a good way for you to invest enough energy in microwave after-sales service.
- Finally, you can track the success index of your products and other competing products according to the equation provided in Section 5.3.2 to ensure that the success index of your company's product is above the average. Once the success index is below the average, it is necessary for you to adjust the sales strategies in time, such as the low-price strategy.

We hope our suggestions are helpful. If you have any question, please feel free to contact us.

Sincerely,

Team # 2007707 of 2020 MCM

Letter

Dear Sunshine Company Marketing Director:

We are honored to inform you of our recommendations for product improvement and sales strategies for your company after data analysis and modeling. The following are some suggestions based on our analysis.

1. Suggestions for product improvement

We apply the LDA analysis model to find the topic feature of each product, in which the negative topic words can reflect the customers' dissatisfaction with the existing products in the market.

Analysis of the review text revealed that the words like "cost", "heavy", "smoking" and "noise" appeared on the top of the list of negative reviews on the hair dryer. After analyzing these high-frequency words one by one, we discovered that there were some drawbacks with hair dryers from the customers' point of view:

- Inefficiency: it takes a long time to blow-dry.
- Weight: it is too heavy to use conveniently.
- Bad quality: when using the product, there will be a lot of noise sometimes.

Therefore, according to the feedback above, we believe that the improvement of hair dryer products is supposed to start from improving the working efficiency and quality of hair dryer. Lightweight materials can be used in the production, reducing the weight of the hair dryer, should also reduce the noise when it works. For instance, lightweight materials can be used to reduce the weight of the hair dryer and reduce the noise while it is working.

As for microwave oven, words like "service" and "small" appeared on the top of the list of negative reviews. According to the feedback, we believe that the microwave oven may have the following defects:

- Size: someone considered that microwave ovens are too small, while others reckon that small ones are more convenient to use.
- Service: the after-sale service of some microwave ovens is not consummate.

In view of the above two points, we hold that microwave oven products can be designed in different sizes to meet the diverse needs of different customers. Moreover, improving service level and customer satisfaction is also a top priority.

"Hot" is the most frequently used negative word for a pacifier. Some customers think that the insulation function of the pacifier is poor, which reminds us that we should enhance the thermal insulation function in the design of the pacifier. In addition, we have noticed that customers attach great importance to the "appearance" of the pacifier and hence the cute product design will help to sell the product.

2. Sales strategy

Through the in-depth analysis of star ratings and reviews, we will propose sales suggestions and strategies from three aspects: the product brand, the time of selling products and the evaluation psychology of customers.

- Recommend the product brand for sale.

Based on the analysis of star rating and review, we summarized five indexes that affect product sales, namely quality, price, appearance, service and size, as well as index weight, then built a brand scoring system based on this. Through the systematic clustering of each score, all product brands were clustered, and the high-quality product brands were selected eventually. The product parent of some premium brands is as follows:

microwave	862802057	423421857	692404913	464779766	423421857
Hair-dryer	244516305	266176173	468944538	741916038	112413045
pacifier	22060147	22189989	51496920	62352351	79207704

Our brand rating system takes full account of the characteristics of each product, so the conclusions are very reliable. It is believed that the high quality brands recommended for sale will be favored by more customers.

➤ Sales opportunities analysis.

we predict the future reputation of the three products through time series analysis. The results demonstrate that the three products are highly correlated with seasonality, and the seasonal cycle pattern is likely to be stable in the future. However, the peaks of reputation composite scores of the three products occurred at different times.

Pacifiers peaked around November, hairdryers around August and October, and microwave ovens around April and October. The peak of reputation will lead to an increase in sales, so we suggest that your company adjust the sales structure according to the peak time of different products. When the product reputation is about to peak, your company can increase the sales investment of the product to obtain higher revenue.

➤ Psychological analysis of customer reviews.

We analyze the relationship between star rating and review. Through the research of distributed lag model, it is found that customers' reviews in the current period will be influenced by other customers' ratings and reviews. Therefore, we suggest that your company should still pay attention to the customer's rating of the goods after selling the products, and try to make the rating of its own products at a high level, so as not to gain a bad impact on future sales. To sum up, by keeping an eye on customers' preferences and regarding them as standards for improving products and services, your company can gradually increase product sales and market share.

These are all suggestions and strategies our team has provided to your company. Thank you again for taking the time to read our suggestions.

Hope that our models and these suggestions can be helpful to you!

Sincerely,
MCM Team Members