

The New Role of the Variance of Ratings on Decision-Making Process, Considering the Loyal Customer's Different Preference in a Brand

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Abstract

Evaluating the combined effect of the average rating and variance of ratings in the consumer decision-making process and its impact on price, demand and profit reveals interesting insights into reducing information asymmetry in e-business. The study examines the effect by constructing a game theory model to extend made under conditions of the loyal customers' different characteristics as their preferences that mediate the effect in the consumer decision-making process. The results show that consumers have higher intentions to consume low quality product with a higher variance, which results in increases price, demand and profit. The study further analyses how consumers' willingness to continue purchasing potentially risky products with a higher variance when they make decisions for two products with similar average ratings. Thus, this study will help managers to anticipate market trends and formulate effective marketing strategies to reduce feelings of uncertainty in the potential buyers purchase decisions.

Keywords: E-business, product ratings, loyal customer preference, information transmission, game-theory model.

1. Introduction

This study constructs a game-theory model as a novel setting for explaining the combined effect of the average rating and the variance in the decision-making process of both seller and consumers and its impact on price and demand. This study assumes that the role of the average rating and the variance depend on the existence of different preferential loyal customers (quality- and prestige-loyal) in the market. The results show that the combined effect of average rating and variance play an important role in explaining the decision-making process in the presence of different preferential loyal customers. By an effective evaluation of the model, sellers and consumers can take advantage to decrease an uncertain in their decision-making, which also decreases information asymmetry between seller and consumer.

The related studies examined the sales impact of online consumer-generated reviews such as average rating and variance of reviews. Chevalier and Mayzlin [7] and Sun [31] investigate the effect of online customer reviews on sale. They found that a higher average rating has a positive effect on book sales. Luca [25] investigates the effect of online consumer reviews on restaurant demand and found that a one-star increase in Yelp rating leads to a 5-9 percent increase in revenue. Dellarocas et al. [11] found that online consumer reviews play a significant role in forecasting the sales of entertainment goods. Moe and Trusov [26] examined the effect of user rating on beauty products sales and found that the average ratings have direct effects on product sales. However, Zhu and Zhang [34] look at the moderating role of the product popularity on the relationship between online reviews and sales. The authors found that the average rating has no effect on demand. Duan et al. [13] analyzed the impact of the ratings of online user reviews on movie box office revenues at Yahoo Movies and Boxoffice Mojo.com. However, the authors did not find a significant impact of reviews on sales.

According to Moon et al. [27], various aspects of review ratings explain consumers' new movie ratings as a measure of consumers' satisfaction with movies. For Sun [31], a higher average rating indicates a high level of quality from the consumers' perspective. The author explains that the average ratings offer as consumers enjoy product in a reasonable degree. These enjoyments contain the properties of reviews which include positive and negative user-generated descriptions of the products (see Chevalier and Mayzlin [7], Dellarocas et al. [11]). Consumers are likely to agree with the reviews, which provide the explications of products regarding positive and negative performances. These are particularly useful when using assess the potential outcome of the purchase decision. Since, consumers more like to compare themselves with previous customers of product, and decide how much the product will meet their needs (see Schiffman et al. [30]). Sequentially, Herrmann et al. [17] have pointed out that consumers can see at a glance which opinions of the customers about the good differ by observing the variance of ratings distribution.

Clemons et al. [8] focused on online consumer reviews, such as beer reviews. The study shows that the variance of reviews as important as the average rating in predicting new product sales. In particular, the study found that the variance of ratings plays an important role in determining which new product grows faster in sales in the hyper-differentiated markets. The authors show that in this kind of market, consumer review has a positive effect on demand. Because, increasing the variety of the products allows consumers to obtain well-matched products. However, the authors did not investigate whether the product meets the fits of a distinguished group of customers and why does this group of customers love the product more than others who merely like the product.

Sun [31] has proposed a simple game theory model to analyze the informational role of the variance of ratings. The author used the model to incorporate the effect of variance into consumer demand analysis. In her model, a high average star rating is an indicator of higher quality, whereas a higher variance of ratings indicates higher mismatch cost of the product that some consumers love and others hate. The author founds that a higher variance of ratings on amazon.com and barnesandnoble.com increases demand

even for books on lower average ratings. However, it is difficult to determine the quality of products with higher variances in her model. Because a higher variance may increase or decrease product evaluations only depending upon consumers' prior expectation on quality and mismatch cost, which could drive away potential consumers.

Herrmann et al. [17] constructed an analytical model that examines the effect of the variance of ratings on price and demand. In their model, product characterized with two attributes, which may cause the variance of ratings: a mismatch between consumer taste as an informed search attribute of product, and product's failure as an experience attribute. The authors found that a higher variance caused by the informed search attributes, indicates that products are liked by some consumers and disliked by others. These result in higher equilibrium price and lower equilibrium demand. A higher variance caused by the experience attributes suggests an unreliable product, it is associated with lower equilibrium price and lower equilibrium demand. Holding the average ratings constant, while increasing the variance caused by the informed search attributes increases equilibrium price and demand for the product with low variance. Theoretical result of Herrmann et al. [17] suggests that a higher variance of ratings has a negative effect on sales. The authors considered that products' experience attributes are transformed into search attributes, which consumers need to read all textual reviews. In real market situations, consumers don't have ability to read thousands of reviews on products right from the store such as Amazon.com, and decide whether products fit their needs on other preferences.

The studies above which analyzed movie, book, restaurant, beer, etc., ratings, assumed that the ratings depend on customers' personal taste. However, customers' evaluations in products' ratings are often followed strongly by their emotional reactions (see Bagozzi et al. [3]), and their loyalty is made up of their emotional thoughts and feelings toward the brand product (see Worthington et al. [32]). Consequently, customers prestige-seeking behavior plays an important role in their product evaluation ratings (see Baek et al. [2], Gilaninia et al. [16]). Thus, by the game-theory model, this study suggests that the combined effect of average rating and variance of ratings in the decision-making process also varies depending on reviewer customers' individual preferences for a product. Consequently, the interaction of the combined effect of average rating and variance could be useful to reduce the risk in the decision-making when both sellers and consumers rely on loyal customers' product evaluation in ratings. In turn, sellers' and consumers' reliance strictly depends on the loyal customers' different preferences as their individual characters which depicted in Figure 1. And more importantly, in terms of the model composition, the combination of average rating and variance turns into more valuable information for analyzing the effect of loyal customers' ratings in the decision-making process of sellers and consumers, and its impact on product price, consumer demand and total profit.

In a departure from previous studies, this study constructs a simple game-theory model to extend the analysis on loyal customer individual preferences that mediate the combined effects of average rating and variance in the decision-making process of sellers and consumers. The model features sellers and loyal customers with heterogeneous taste.

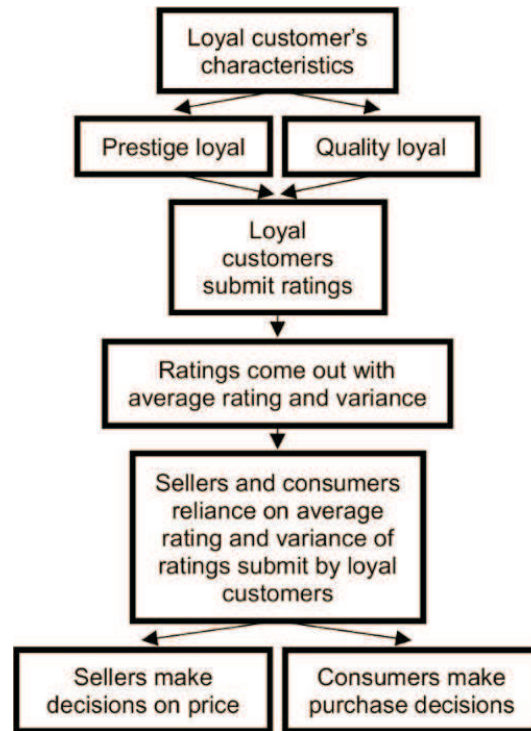


Figure 1: Conceptual framework.

Loyal customers are divided up into two groups, named as “prestige-loyal customers” and “quality-loyal customers”. Each group is characterized by customers’ consciously preferred behaviors in the buying decisions. Thus, this study makes notable contributions to current understandings how consumers and sellers incorporate the variance of ratings in their decision-making process.

2. Model Development

2.1. Role of ratings distribution in consumer decision-making process

Customer loyalty manifests itself in behavioral consequences including repurchase behavior (see Dickinson [12]), spreading positive WOM communication (see Rundle-Thiele and Bennett [29]). According to Oliver’s [28] loyalty framework, perceivable quality of a certain brand indicates that it is desirable than other alternatives. This perceived value leads to satisfaction (see Dabholkar et al. [10], Dickinson [12]). On the other hand, according to Hughes [20], most of the certain branded products can be explained by how much status they give their owners. To sum up, customers who are loyal to a brand, believe in the highest quality offer from their brand. These customers like having higher quality products, while others prefer to buy products that give them greater prestige. Thereby, in this study, customers are divided into two groups according to their preferences, named “prestige-loyal customers”, PLC and “quality-loyal customers”,

QLC. Both customer groups are assumed mutually exclusive. Thus, PLC are seeking to gain a prestige or a status by consuming these products. Involving prestige or status into consumption, leads to purchasing higher-priced products (see Eastman et al. [14]). Because, PLC are more like to show their self in front of others that they look different and they have higher prestige than others by showing what they have. PLC purchase their lovely brand even if other similar branded products are higher quality or cheaper. For the reason that they are seeking to gain prestige from the products regardless of quality levels and they always assign it higher ratings. Conversely, QLC are likely to have preferences for high quality products. QLC assign higher ratings for products if the quality of product well enough to make satisfy them, otherwise assign it lower ratings. On the other hand, QLC love the product if and only if any characteristics of it matches with their taste, and they assign lower ratings. Moreover, currently, most popular online stores such as Amazon, encourage customers to disclose their preferences for products by the rates products. The information generated by the early customers in ratings provides signals to identify their preferences. These are key factors in the later consumers' decision-making. The later consumers compare themselves with previous customers of the product and make buying decisions in keeping previous customers' preferences in mind (see Schiffman et al. [30]).

Further assumptions imply that sellers can offer high- and low-quality products from the customers' perspective. For potential buyers have no way of knowing whether sellers offer high- or low-quality products before consumption. Products are not labelled with high- or low-quality brand labels. Using these assumptions, this study determines the role of ratings as the average rating and the variance of ratings in decision-making process by focusing on conditional probability in the model. Involving the conditional probability scenario in the model makes modeling easier to understand how customers' preferences as a combination factor in ratings play a role in the decision-making process.

2.1.1. Evaluating decision-making process for the case of high-quality product

Loyal customers buy repeatedly the branded products' new version presuming to satisfy their needs. In the early-sale period of the products' new version, loyal customers post reviews after consumption. The initial reviews, average rating and variance of ratings are important information resource for the later consumers. It reduces uncertainty in the later consumers' purchase decisions. Reviews represent the customers' intentions that they want to inform others about their experiences on product after actual use of the product (see Liu [24]). In fact, consumers' purchase decisions are most influenced by the average rating. Consumers are more likely to find the average rating to be helpful. A higher average rating as an indicator of high-quality product from consumers' perspectives, and it increases trust towards the branded product (see Sun [31]). With a higher average rating, a higher variance reflects how honestly differences of opinion exist between reviewer customers about the product (see Herrmann et al. [17]).

If the seller offers a high-quality product, then the better chance is that all the loyal customers like the product and post positive reviews. When the products' quality G is

high H , both PLC, X and QLC, Y of the same product submit higher ratings and get the product that meets their preferences, and satisfy their needs. The probability of the ratings' distribution for the term of two separate groups is given as: $Pr(Z | G = H, X) = Pr(M = h, V = l)$ and $Pr(Z | G = H, Y) = Pr(M = h, V = l)$, as shown in Figure 2. Thus, the probability of ratings distribution in the case of existence two customer groups can be formulated as follows:

$$Pr(Z | G = H) = Pr(Z | G = H, X) + Pr(Z | G = H, Y) = Pr(M = h, V = l) \quad (2.1)$$

where

$Z = P \cdot X + (1 - P) \cdot Y$, Z is ratings distribution for the different customer groups.

$P = X/(X + Y)$, P is proportion of the two different customers' groups, $P \in (0, 1)$.

Eq. (2.1) yields a higher average rating and a lower variance if the proportion of the customer groups in $P \in (0, 1)$. Consumers, who arrive late to the market, trust the average rating and the variance of ratings to make an informed purchase decision. From the consumers' perspectives, a higher average rating indicates higher quality of the product, which attracts consumers' attention. A lower variance simultaneously communicates to consumers that the quality of the product is high because both PLC and QLC love it.

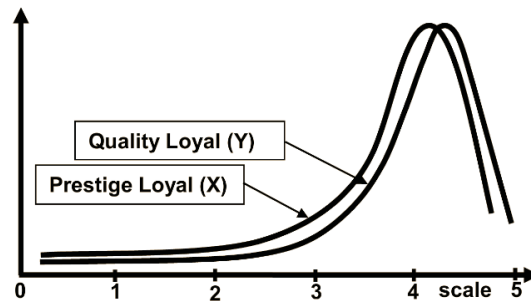


Figure 2: Probability of the ratings' distribution of the term of two separate customer groups in the case of high-quality product.

2.1.2. Evaluating decision-making process for the case of low-quality product

Currently the business owners sell their product very selectively by the goal of reaching a distinguished customer group. They employ several different branding strategies that affect all aspects of their business by including direct connection to customers with their preferences and needs. Customers prefer to buy products that meet their needs or obtain brands as it enhances their prestige. If the seller offers low L quality G product, PLC, X assign higher ratings, but QLC, Y of the same product assign lower ratings. In this case, the distribution of QLC' ratings (variance) would be narrow, but a bit larger than in the case of higher quality product, because some of the QLC' tastes still matches with product's specific characteristics. This was also endorsed by Sun [31]'s observations that customers prefer to obtain low quality product if and only if some attributes of

the product meet their needs. For example, customers are demanding the product if they like its design, color, etc., although its quality attributes are low (low CPU speed, cameras' lower resolutions). Instead, the distribution of PLC' ratings (variance) would be larger. Boven [5] suggests that the need for new, fashionable clothes or newer and larger car, can be legitimized by saying "it is for dressing appropriately at work" or "for to haul the family and driver safety in inclement weather". Accordingly, PLC are not purchasing for their basic needs. For example, acquiring high CPU usage laptops or cell phones, is not desired for efficiency at work or personal communication for these customers. For customers, these attributes are an indication of the prestige rather than the quality attributes. As they largely make judgments based on what they consume and represent by what they have with superior features than others have. Their preferences strictly influence to differ their opinions about the product's different features. This results in different satisfaction levels of them. Where customers' opinions are differing more about the product, as shown in Figure 3, the probability of the ratings distribution for the term of two groups given as: $Pr(Z | G = L, X) = Pr(M = h, V = l)$ and $Pr(Z | G = L, Y) = Pr(M = h, V = l)$. Where the product quality is low, there more dramatic change of the rating distribution depends on the proportion of two different customer groups. Thus, the ratings distribution can be formulated as follows:

$$Pr(Z | G = L) = Pr(Z | G = L, X) + Pr(Z | G = L, Y) = Pr(M = l, V = l). \quad (2.2)$$

Eq. (2.2) yields a lower average rating and a lower variance if the proportion of the customer groups is approximately equal to zero, $P \approx 0$. A lower average rating signals low quality of the product from the consumers' perspectives, and it might drives away marginal consumers. Along with it, a lower variance communicates to consumers that the quality of the product is low, because product only has unsatisfied QLC, which decreases demand for the product.

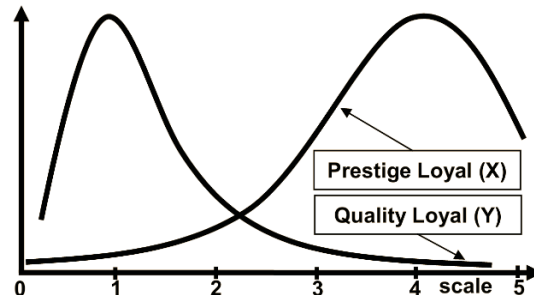


Figure 3: Probability of ratings' distribution of the term of two separate customer groups in the case of low-quality product.

Accordingly, the probability of the ratings distribution can be formulated as follows:

$$Pr(Z | G = L) = Pr(Z | G = L, X) + Pr(Z | G = L, Y) = Pr(M = l, V = h). \quad (2.3)$$

Eq. (2.3) yields a lower average rating and a higher variance if and only if the proportion of the customer groups is $0 < P < 0.5$, $P \neq 0$. When average rating is low,

still some customers are interested in the product. A higher variance shows that product quality is low, because the majority of the product's customers are well-matched QLC and a few PLC, which increase demand for the product.

Respectively, the probability of the rating distribution can be formulated as follows:

$$Pr(Z | G = L) = Pr(Z | G = L, X) + Pr(Z | G = L, Y) = Pr(M = h, V = h). \quad (2.4)$$

Eq. (2.4) yields a higher average rating and a higher variance if the proportion of the customer groups is approximately equal to one, $P \approx 1$. In this case, a higher average rating attracts more consumers' attention that the product has a higher quality. On the other hand, the higher variance indicates that the product has an unreliable quality, even though it has a higher average rating, which only PLC love the product. Therefore, demand decreases for the product.

2.2. The sellers' pricing strategy under an evaluated quality condition

The study analyzes the combined effect of average rating and variance of rating in consumers' decision-making process and on sellers' pricing strategy by developing a simple game theoretical model. The model featuring sellers and loyal customers with heterogeneous tastes. In the model, the product defined with two attributes: quality and mismatch cost. A good quality product is liked by all the consumers, and it keeps consumers coming again to buy from the same market. The quality denoted by \cdot . The quality attributes are defined precisely in the measure for the attributes, which generally can be refined for the product. Higher resolutions of the digital cameras, central processing speeds of the computers can be good examples. These attributes determine the quality of the product from the consumers' perspective, and affect consumers' purchasing decisions. The mismatch costs are the same as discussed in Sun [31], captures "aspects of the product that would have an influence on how much customers would differ in their enjoyment of the product". Mismatch cost perceived differently among customers, it negatively affects customers' enjoyment in product depending on their taste. Some customers may love the different colors of the camera or a differently shaped design of a mobile phone. Although each of the customers has his/her own specific needs and tastes based on his/her preference, all the customers agree on general quality attributes of the product. In addition, all the customers submit only a one-star rating that conceptually captures both dimensions. For instance, can find customers reviews helpful at Amazon: "I love my iPhone 6 but I'd love it more if it had a Galaxy S6 Edge camera" - PLC' opinions; another customer wrote "I love my new S7 although its battery seems to be running down faster than I expected" - PLC' opinions; and one other customer wrote "this laptop with Linux OS is best for whose majors is a computer science" - QLC' opinions. The mismatch costs denoted by t and assuming $t \in [0, 1]$.

The study considers heterogeneous customers' tastes with respect to product's attribute as discussed in Sun [31]. Customers' preferences in the model are defined as the individual tastes as measured by the utility. The customer taste denoted by z , which is uniformly distributed between zero and one, $z \in [0, 1]$, where customers are located

uniformly on Hotelling line (see Hotelling [19]). The product perfectly matches the customers' tastes when customers preferentially located at near zero. If the customers located a distance z from the product and buy it at a price P then their utility given as:

$$U = v - t \cdot z - P. \quad (2.5)$$

Expressed the mismatch cost in Eq. (2.5) suggests that customers with different tastes will derive the same or higher utility from product in the extreme case of $t = 0$. That is, customers located near the product enjoy the product more. A higher mismatch cost suggests that customers with different tastes will derive different utility from the product, which has higher mismatch cost and only meets distinguished customers' needs.

In order to fully understand the difference between the product attributes (quality and mismatch cost) and identifying the taste parameter z , it is important to explain with suitable example. Dell XPS is one of the most renowned laptops, which is considered the best Linux laptop. Loyal customers of the Dell laptops know how much they love Dell laptops (customers distance from the product) but they don't know how CPU is running on a new version (the quality attribute of the product) and how much they will enjoy Dell XPS with Linux OS (the mismatch attribute of the product). As above, the quality and the mismatch cost are inherent to the product. However, the taste parameter varies across customers, which the customers' tastes are differing on the product. Thus, the customers in their decision-making process know their tastes as the distance from the product, but they do not know quality and mismatch cost of the product without further information.

Usually, the seller does not provide detailed information on the product's all characteristics when the product's new version is released or enters the market. Neither the seller nor loyal customers know the realization of quality and mismatch cost. The seller sets own price. In customers' case, the expectation built on the experience derived from the product's previous version makes the early loyal customers expect that product will fit their needs. Loyal customers who decide to purchase, they learn about the product's specifically distinct characteristics as well as the realization of quality and mismatch cost through consumption. After the realization of quality and mismatch cost, customers submit ratings that are equal to difference between true utility and expected utility. The late consumers observe the entire distribution of ratings to update their beliefs on the product's characteristics for making purchase decisions. This assumes that customers submit honest ratings for products, which there is no external manipulation of customer reviews (see Li and Hitt [22]). Also, the ratings are submitted by loyal customers that once they had been consumed the product (see Anderson and Simester [1]). Thus, later consumers decide how the product will meet their needs by observing the ratings which are submitted by loyal customers. Then, the seller sets the right price based on gathered information. See the structure of the model as shown in Figure 4.

Some features of the model are noteworthy. In the model, customers put more weight on quality and mismatch cost in the purchase decision, and the ratings given by customers equal their consumption utility. In addition, the customers do not fully take

into account price when they judge product in the ratings whether or not it fits their needs, which led them higher or lower utility. For example, customer review as, “this laptop with Linux OS is best for whose majors is a computer science”. The review shows that even the product with higher mismatch still fits some customers’ needs regardless of the level of price. In this case, the price might not play a decisive role in the rating evaluation of the product. Therefore, the price is excluded from customers’ utility when writing utility as a function of the ratings, which would not affect the analysis.

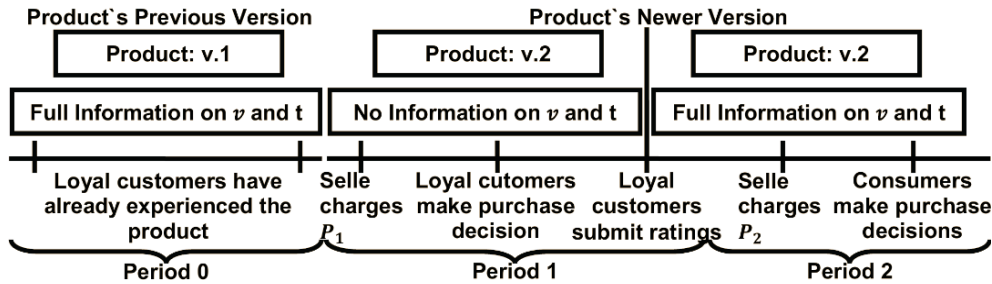


Figure 4: The structure of the model.

Loyal customers make purchase decision if their predictions of expected utility $E(U)$ is greater than the utility U_0 derived from the product’s previous version, do not purchase otherwise. Each of the loyal customers has a unit demand; they buy one unit of the product and receives a utility of zero when not buying the product. The seller offers the new version of the product with a starting price P_1 and loyal customers decide whether to buy one unit of the product based on expected utility which is built on experience they got from product’s previous version. Customers, who buy the product, submit ratings that equal true utility $U = v - tz$ derived from the product’s new version after realization of expected utility $E(U)$. In the later sales cycle of the product, later consumers enter the market. The seller and later consumers observe the ratings as well as mean and variance of ratings given by early loyal customers. Based on information gathered in the product’s early sales cycle, the seller chooses to change price P_2 and later consumers decide whether to buy the product.

In the first period of the game, without information on quality and mismatch cost, early loyal customers make their purchase decisions based on expected utility $E(U)$ which is weighted on expectations of v and t , denoted by $E(v)$ and $E(t)$, respectively $E(U) = E(v) - E(t)D_1 - P_1$. The expected utility depends upon experienced utility $U_0 = v_0 - t_0z - P_0$ derived from previous version of the product that customers already have full information on and .The utility derived from the product’s previous version certain-emotional appeals, it makes customers feel certain when they make purchase decisions on the new version of the product. The statement above is true and sufficient condition is $z \sim F(z)$, $P_r(Z \leq z) = F(z) = z$, $F(z) \in \{0, 1\}$, $U \in (0, 1)$.

Loyal customers go through evaluating product in the ratings after consumption. If loyal customers’ expected utility based on their experience is lower than true utility

$v - tz \geq E(U)$, the loyal customers are satisfied with the product. The probability of this is $P_r(Z \leq v - tz) = F(v - tz)$ and customers submit the satisfaction ratings equal $G_1(v - tz)$. If loyal customers' expected utility based on their experience is higher than true utility $v - tz < E(U)$, the loyal customers dissatisfied with the product or they are less satisfied with their choice. The probability of this is $P_r(Z \leq v - tz) = 1 - F(v - tz)$ and customers submit the dissatisfaction ratings equal to $G_2(v - tz)$. Thus, probability of the expected rating equals:

$$E(R) = [F(v - tz)] \cdot [G_1(v - tz)] + [1 - F(v - tz)] \cdot [G_2(v - tz)]$$

Considering the distribution of ratings: loyal customers with $z \in [0, 1]$ buy the product; customers located at $z = 0$ have a perfect fit with the product that drive higher or same higher utility. Where customers located at distance D_1 then they drive lower or different utility. However, loyal customers would be indifferent in purchasing the product, their rating can be either higher or lower depending on whether prior expected utility exceeds or falls of true utility. As above, the true utility weighted according to the expectation of expected v and t . If quality fits all customers' expectations, it leads higher utility and results in higher rating evaluation. Increasing mismatch cost causes larger differences in ratings that only a group of the customers derives different and higher utility. Consequently, ratings are uniformly distributed in $[0, D_1]$ and the average rating M and variance V of ratings can be computed as:

$$M = v - \frac{3}{4}tD \quad \text{and} \quad V = \frac{1}{144}(tD)^2. \quad (2.6)$$

In the second period of the game, later consumers come to market. They learn about the product by observing average rating and variance such as product characteristics. Consumers can directly learn about v and t by mathematically solving Eq. (2.6):

$$v = M + 9\sqrt{V} \quad \text{and} \quad t = \frac{12\sqrt{V}}{D}. \quad (2.7)$$

A higher average rating indicates generally good quality of the product and holds the loyal customers' different preferences toward branded products. A higher variance suggests that loyal customers' preferences change toward the product depending on whether the product matches their tastes. Eq. (2.7) shows that there is complete information in the second period of the game, which later consumers can get perfect information about quality and mismatch cost that leading a certain purchase decision.

Given the complete information in the second period, the utility of the later consumers is $U_2 = v - t \cdot z_2 - P_2$. The seller drives the taste of consumers as a function of the price based on U_2 . The late consumer demand D_2 is also equal z_2 that the taste is uniformly distributed. The demand in the second period is equal $D_2 = (v - P_2)/t$ where the seller maximizes profits by solving $P_2(v - P_2)/t$. Equilibrium levels of second period price, demand and profit are:

$$P_2^* = \frac{v}{2}, \quad D_2^* = \frac{v}{2t} \quad \text{and} \quad \Pi_2^* = \frac{v^2}{4t}. \quad (2.8)$$

Correspondence between the product's attributes and ratings given as in Eq. (2.8), the second period equilibrium outcomes can be computed as follows:

$$P_2^* = \frac{M + 9\sqrt{V}}{2}, \quad D_2^* = \frac{D_1}{24} \left(\frac{M}{\sqrt{V}} + 9 \right) \quad \text{and} \quad \Pi_2^* = \frac{D_1}{48} \left(\frac{M^2}{\sqrt{V}} + 81\sqrt{V} + 18M \right). \quad (2.9)$$

Eq. (2.9) presents the effects of M and V on equilibrium outcomes and suggests that both M and V play an important role in determining the second-period market outcomes, as in the following propositions:

Proposition 1. *Equilibrium price, equilibrium demand and equilibrium profit all increase with the average rating.*

Proof. Differentiating the equilibrium outcomes with respect to M gives, $\partial P_2^*/\partial M = 1/2$, $\partial D_2^*/\partial M = D_1/24\sqrt{V}$ and $\partial \Pi_2^*/\partial M = D_1(M + \sqrt{V})/24\sqrt{V}$. Since M , V and D_1 are positive by definition, thus $\partial P_2^*/\partial M > 0$, $\partial D_2^*/\partial M > 0$ and $\partial \Pi_2^*/\partial M > 0$, mathematical proof is complete.

The intuition behind Proposition 1 is that average rating is a credible signal about the quality of the product; a higher average rating signals a high-quality product. The seller sets higher price and consumers show higher demand for the product with higher quality. Empirical evidence based studies support this prediction. Consuegra et al. [9] found that customers choose to accept higher priced product which product leads a higher satisfaction. Bruce et al. [6] found that the seller increases price when consumers have higher satisfaction with the product. Also, the proposition represents the theoretical confirmation of empirical findings in the related studies. For example, Chevalier and Mayzlin [7] and Sun [31] found that a higher average rating leads higher sales.

Now the focus is on the main proposition of the paper, which examines the combined effects of average ratings and variance of ratings on the equilibrium outcomes.

Proposition 2. *Equilibrium price increases, equilibrium demand increases if and only if $M \leq 0$, equilibrium profit increases if and only if $M \leq 9\sqrt{V}$, with the variance of the ratings.*

Proof. Differentiating the equilibrium outcomes with respect to V gives, $\partial P_2^*/\partial V = 9/4\sqrt{V}$, $\partial D_2^*/\partial V = -MD_1/48V\sqrt{V}$ and $\partial \Pi_2^*/\partial V = D_1(81V - M^2)/96V\sqrt{V}$. Since M , V and D_1 are positive by definition, thus, $\partial P_2^*/\partial V > 0$, $\partial D_2^*/\partial V < 0$ and $\partial \Pi_2^*/\partial V > 0$, mathematical proof is complete.

The intuition behind proposition 2 as follows: when the product receives a higher average rating, consumers expect the high-quality and safe product. A higher variance communicates to consumers that the product's quality is low, because the product only fits PLC needs, and it indicates that mismatch cost of the product is relatively high. This mean, PLC are the best in choosing a substitute product with its superior features, which would meet their needs based on their preferences due to different taste. Therefore, the seller charges possible price, which enables seller to capture PLC with their willingness to pay a higher price. The seller easily sets a maximum price, because a higher brand loyalty

keeps the customers less focused on price than benefits of the brand (see Consuegra et al. [9]). Maxim increase of the price also results in a maximal increase in seller's total profit.

When the product receives a lower average rating, consumers are uncertain on quality judgments. Although a higher variance signals low quality of the product, it shows that still QLC and a few of PLC are interested in the product. In addition, a higher variance indicates higher mismatch cost of the product. This mean, QLC enjoy consuming the product with right tastes much more than the average rating would suggest, which reflects the perceived performance of the product. Therefore, the seller charges a higher price and secures demand from perfect-matched QLC to cream skim the higher willingness to pay of the customers with right tastes.

When the product receives a higher average rating, consumers perceive more certainty higher quality of the product, which led to higher purchase intention. A lower variance confirms the higher quality of the product, which results in satisfied both PLC and QLC. It reduces suspicions about the product quality in both seller and consumer decision-making process, which causes higher price, demand and profit.

More interesting, when the product receives a lower average rating, a lower variance confirms the lower quality of the product; it signals that the product only has dissatisfied QLC, which decreases demand. In this case, the seller should extend product attributes, which increases the mismatch cost of the product. Additional product attributes allow reducing consumer heterogeneity in mismatching with the product that enables more consumers to purchase what offered by the seller (see Liu and Cui [23]). Consequently, QLC can evaluate one or more attributes which satisfy their needs. It results in more well-matched consumers to purchase and increases the sellers' total profits.

3. Empirical Validation

3.1. Data

The sellers and potential consumers are able to correctly identify the distribution of ratings, which reflects an observed average rating. The rating distribution serves as visual proxy for variance estimation. The actual 500 items of data were obtained from the best Mobile Phone seller on the Internet, Amazon.com. The data was collected from Amazon, because its product ratings are commonly sought after by potential buyers and easier to track the product on the website. For each Mobile Phone, the number of reviews, numerical values of the ratings, sales rank and price were recorded. The average rating and variance for each item were computed on the numerical values of the ratings. According to Khare et al. [21], many of the effects don't exist at low numbers of reviews. Therefore, the 400 items with over 1000 reviews were chosen. Then, the concept of standardized variables that were measured on the same scale for giving an equal contribution to the analysis was used. Total 400 items were manipulated took part in 100 items at a higher average rating vs. a higher variance, 100 items at a higher average rating vs. a lower variance, 100 items at a lower average rating vs. a higher variance, 100 items at a lower average rating vs. a lower variance multivariate regression measure.

3.2. Results

A 1 (*average rating*) \times 1 (*variance*) \times 1 (*average rating* \times *variance*) | 1 (*low average rating vs. low variance*) multivariate regression with the sales rank and price as dependent variables in the decision-making process, revealed a significant and negative two-way interaction between variance and average rating, and significant-positive main effect of the average rating for price and sales rank (demand), as shown in Table 1. In the case of $\text{Mean}_{\text{low-ave.rating}} = 3.40$ vs. $\text{Mean}_{\text{low-variance}} = 0.88$, the main effect of the average rating and two-way interaction between average rating vs. variance play a significant role in the decision-making process. The significant combined effect is that it accurately reflects the decision-making of the seller and customers in a shopping process. It shows that, both demand (sales rank) and price decrease when a product received a low average rating and a low variance. The reason behind is that customers put more weight on their quality-seeking intentions in decision-making on the product, which is reflected by the average rating. More precisely, quality-loyal customers' quality-seeking intentions play a dominant role in their decision-making process. It is true for the product where the entirely quality-seeking intentions are involved in the potential consumers' decision-making process.

Thus, consumers' quality-seeking intentions involve in their purchase decision-making as the dominant factor when the product received a lower average rating and a lower variance, the demand decreases for the product because of low product quality. The seller decreases the price based on the observed situation where the consumers perceive low product quality with a lower average rating and a lower variance. Lastly, it's found the combined effect of the variance vs. average rating is significantly negative on demand (sales rank) and on price when the product received a lower average rating and a lower variance.

Table 1: Multivariate regression with the sales rank and price as dependent variables when both average rating and variance are low.

	Coef.	SE	<i>t</i>	$P > t $	[95%	CI]	Beta
Price							
Ave.Rating	.242	.102	2.38	0.020	.040	.444	.242
Variance	-.048	.118	-0.41	0.682	-.283	.186	-.048
Ave.Rating \times Variance ^a	-.163	.078	-2.08	0.041	-.318	-.007	-.243
_cons	-.064	-.096	-0.66	0.512	-.256	.129	
SaleRank							
Ave.Rating	.335	.098	3.40	0.001	.139	.531	.335
Variance	-.024	.114	-0.21	0.831	-.251	.202	-.024
Ave.Rating \times Variance ^b	-.156	.076	-2.05	0.043	-.307	-.005	-.233
_cons	-.061	.093	-0.65	0.517	-.247	.125	

^a($F(3, 96) = 7.43, p < 0.05, R^2 = 0.188, \text{Adj.}R^2 = 0.163$)

^b($F(3.96) = 10.09, p < 0.05, R^2 = 0.240, \text{Adj.}R^2 = 0.216$).

A 1 (*average rating*) \times 1 (*variance*) \times 1 (*average rating* \times *variance*) | 1 (*low average rating vs. high variance*) multivariate regression with sales rank and price as de-

pendent variables in the decision-making process, revealed a significant and positive two-way interaction between variance and average rating, and significant-negative main effect of the variance, as shown in Table 2. In the case of $\text{Mean}_{\text{low-ave.rating}} = 3.20$ vs. $\text{Mean}_{\text{high-variance}} = 1.44$, the main effect of the variance and two-way interaction between average rating vs. variance plays a significant role in the decision-making process. The significant combined effect accurately reflects the decision-making of both seller and customers in a shopping process. It shows that both demand (sales rank) and price increase when product received a low average rating and high variance. The reason is that, customers put more weight on different tastes in their decision-making on product, which is reflected by higher variance. Indeed, quality-loyal customers' different tastes play a dominant role in the decision-making process. It is particularly true for the products where entirely different tastes preferences are involved in the potential consumers' decision-making process.

Accordingly, consumers' different taste preferences are the dominant factor that they consider in purchase decisions when product received a lower average rating and higher variance. That is, demand increases and the seller sets efficiently price based on observing the situation. Lastly, it's found find that the combined effects of the variance vs. average rating have significantly positive effect on demand (sale rank) and price when product received a lower average rating and higher variance.

More interesting, the analyses show that in the case of products received lower average ratings, the interaction between product price, consumer demand, and variance vs. average rating in the decision-making process is significant. The difference in decision-making for two products with similarly low average ratings is greater when the effect of the variance is significant instead of the average ratings effects: $\text{Mean}_{\text{low-ave.rating}} = 3.40$, $\text{Mean}_{\text{low-variance}} = 0.88$, $\text{Mean}_{\text{price}} = 346.56$, $\text{Mean}_{\text{sale.rank}} = 350.05$ vs. $\text{Mean}_{\text{low-ave.rating}} = 3.20$, $\text{Mean}_{\text{high-variance}} = 1.44$, $\text{Mean}_{\text{price}} = 411.36$, $\text{Mean}_{\text{sale.rank}} = 562.84$; $F_{\text{price}}(1, 98) = 30.42$, $p < 0.05$, $F_{\text{sale.rank}}(1, 98) = 27.55$, $p < 0.05$. The prediction that decision-making for two products with similar low average ratings is greater when the variance is high, as shown in Figure 5.

A 1 (average rating) \times 1 (variance) \times 1 (average rating \times variance) | 1 (high average rating vs. low variance) multivariate regression with sales rank and price as dependent variables in the decision-making process, revealed a significant and positive two-way interaction between variance and average rating, and significant-positive main effect of the average rating, as shown in Table 3. In the case of $\text{Mean}_{\text{high-ave.rating}} = 4.38$ vs. $\text{Mean}_{\text{low-variance}} = 0.89$, the main effect of the average rating and two-way interaction between average rating vs. variance plays a significant role in the decision-making process. The significant combined effect accurately reflects the decision-making of both seller and customers in a shopping process. It shows that, both demand (sales rank) and price increases when product received a higher average rating and a lower variance. The reason customers put more weight on their quality-seeking intentions in decision-making is reflected by the higher average rating. Specifically, quality-loyal customers' quality-seeking intentions play a dominant role in their decision-making process. It is true

Table 2: Multivariate regression with the sales rank and price as dependent variables when average rating is low and variance is high.

	Coef.	SE	t	$P > t $	[95% CI]	Beta
Price						
Ave.Rating	.096	.097	0.97	0.331	-.099 .293	.097
Variance	-.275	.098	-2.79	0.006	-.471 -.079	-.275
Ave.Rating \times Variance ^a	.179	.085	2.10	0.038	.010 .348	.206
_cons	.035	.097	0.36	0.716	-.158 .229	
SaleRank						
Ave.Rating	.097	.100	0.97	0.335	-.102 .296	.097
Variance	-.212	.100	-2.12	0.037	-.411 -.013	-.212
Ave.Rating \times Variance ^b	.184	.086	2.12	0.036	.012 .355	.211
_cons	.036	.098	0.37	0.713	-.160 .233	

^a($F(3, 96) = 4.15, p < 0.05, R^2 = 0.115, \text{Adj.}R^2 = 0.087$)

^b($F(3.96) = 3.07, p < 0.05, R^2 = 0.187, \text{Adj.}R^2 = 0.059$).

for the product where entirely quality-seeking intentions are involved in the consumers' decision-making process.

Thus, consumers' quality-seeking intentions are the dominant factor that they consider in their purchase decisions when the product received a higher average rating and lower variance; the demand increases for the high-quality product. Therefore, the seller increases price since potential consumers prefer more of the high-quality product. Lastly, it's found that the combined effects of the variance vs. average rating have a significantly positive effect on demand (sale rank) and price when the product received a higher average rating and a lower variance.

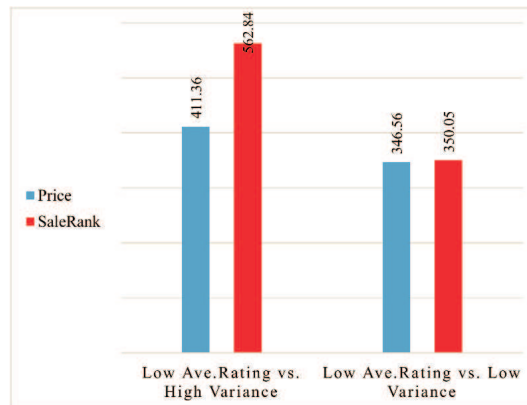


Figure 5: Impact of the variance on price and demand when average rating is low.

A 1 (average rating) \times 1 (variance) \times 1 (average rating \times variance) | 1 (high average rating vs. high variance) multivariate regression with the sales rank and the price as dependent variables in the decision-making process, revealed a significant and positive two-way interaction between variance and average rating, and significant-negative main

Table 3: Multivariate regression with the sales rank and price as dependent variables when average rating is high and variance is low.

	Coef.	SE	<i>t</i>	$P > t $	[95% CI]	Beta
Price						
Ave.Rating	.481	.091	5.27	0.001	.299 .663	.481
Variance	-.052	.089	-0.58	0.562	-.230 .126	-.052
Ave.Rating × Variance ^a	.174	.079	2.19	0.031	.016 .331	.198
_cons	.026	.089	0.29	0.772	-.151 .203	
SaleRank						
Ave.Rating	.472	.092	5.12	0.001	.289 .655	.472
Variance	.091	-0.30	0.762	-.208	.152 -.028	
Ave.Rating × Variance ^b	.178	.079	2.22	0.029	.019 .336	.203
_cons	.027	.090	0.29	0.769	-.152 .206	

^a($F(3, 96) = 10.48, p < 0.05, R^2 = 0.247, \text{Adj.}R^2 = 0.223$)

^b($F(3.96) = 9.76, p < 0.05, R^2 = 0.234, \text{Adj.}R^2 = 0.210$).

effect of the variance, as shown in Table 4. In the case of $\text{Mean}_{\text{high-ave.rating}} = 4.09$ vs. $\text{Mean}_{\text{high-variance}} = 1.37$, the main effect of the variance and two-way interaction between average rating vs. variance play a significant role in the decision-making process. The combined effect accurately reflects the decision-making of both seller and customers in a shopping process. It shows that, both demand (sales rank) and price increase when product received a higher average rating and a higher variance. The reason is that customers put more weight on their prestige-seeking intentions in the decision-making, which is reflected by the higher variance. Precisely, prestige-loyal customers' prestige-seeking intentions play a dominant role in the decision-making process. It is true for the product where entirely prestige-seeking intentions are involved in the potential consumers' decision-making process.

Table 4: Multivariate regression with the sales rank and price as dependent variables when both average rating and variance are high.

	Coef.	SE	<i>t</i>	$P > t $	[95% CI]	Beta
Price						
Ave.Rating	.017	.127	0.13	0.897	-.236 .269	.017
Variance	-.248	.123	-2.01	0.047	-.492 -.003	-.248
Ave.Rating × Variance ^a	.155	.071	2.20	0.030	.015 .295	.219
_cons	.097	.105	0.93	0.356	-.111 .306	
SaleRank						
Ave.Rating	.050	.126	0.40	0.692	-.200 .301	.050
Variance	-.247	.122	-2.03	0.045	-.490 -.010	-.248
Ave.Rating × Variance ^b	.156	.069	2.24	0.027	.017 .295	.221
_cons	.098	.104	0.94	0.347	-.108 .305	

^a($F(3, 96) = 4.61, p < 0.05, R^2 = 0.126, \text{Adj.}R^2 = 0.099$)

^b($F(3.96) = 5.35, p < 0.05, R^2 = 0.143, \text{Adj.}R^2 = 0.116$).

Hence, consumers' prestige-seeking intentions are the dominant factor in making a purchase decision for the product that received a higher average rating and a higher variance; higher prestige intentions of the potential consumers cause to increase demand for the product. Therefore, the seller sets price as high as possible for the consumers who are ready to purchase for prestige product. Lastly, it's found that combined effects of the variance vs. average rating have significantly positive effect on demand (sales rank) and on price when the product received a higher average rating and a higher variance.

Finally and more interesting, analyses show that in the case where product received higher average ratings, the interaction between product price, consumer demand, and variance vs. average rating in the decision-making process is significant. The difference in decision-making for two products with similarly high average ratings is greater when the effect of the variance is significant instead of the average ratings effects: $\text{Mean}_{\text{high-ave.rating}} = 4.38$, $\text{Mean}_{\text{low-variance}} = 0.89$, $\text{Mean}_{\text{price}} = 478.29$, $\text{Mean}_{\text{sale.rank}} = 571.22$ vs. $\text{Mean}_{\text{high-ave.rating}} = 4.09$, $\text{Mean}_{\text{high-variance}} = 1.37$, $\text{Mean}_{\text{price}} = 523.61$, $\text{Mean}_{\text{sale.rank}} = 634.03$; $F_{\text{price}}(1, 98) = 8.63$, $p < 0.05$, $F_{\text{sale.rank}}(1, 98) = 17.23$, $p < 0.05$. The prediction that decision-making for two products with similarly-high average ratings is greater when the variance is high, as shown in Figure 6.

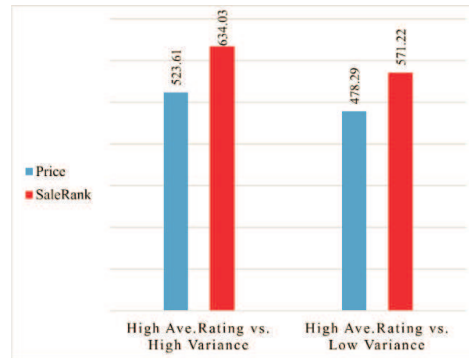


Figure 6: Impact of the variance on price and demand when average rating is high.

4. Discussion

The findings show that combined effect has a significantly negative effect on price and demand (sales rank) in the decision-making process when products received lower average ratings and lower variance ($\beta_{\text{price}} = -0.243$ and $\beta_{\text{sale.rank}} = -0.233$, see Table 1). It has a significantly positive effect on price and demand (sales rank) when products received lower average ratings and higher variance ($\beta_{\text{price}} = 0.206$ and $\beta_{\text{sale.rank}} = 0.211$, see Table 2). Consequently, the combined effect has a positive-greater influence to the decision-making when the variance of the ratings distribution is high for one of the products which both are received similarly lower average ratings, where that product is appearing on the market of prestige-seeking loyal customers. However, it has a negative influence on the product which has received a lower variance, where the market consists of the quality-seeking loyal customers.

Comparing the effect of the higher variance when the average rating is low, an important difference exists in the decision-making process in the case of the existence of the quality-seeking loyal customers in the market. In contrast to Herrmann et al. [17], a higher variance increases demand even when the average rating is relatively low. In this case, a higher familiarity (great customer experience) of the consumers lead to feeding diagnostic information the decision-making process, which results in reduce the mismatch between product and consumers. Familiar and reputable brands give additional signals about the product that positively influences consumers' decision-making (see Ho-Dac et al. [18]). That is, consumers are well satisfied in product with its specifically-distinguished characteristics which perfectly matched their taste. This finding is also supported by Sun [31] that even the product with a lower average rating, still well-matched consumers love product in the a higher variance condition.

Accordingly, the combined effect has a significantly positive effect on price and demand (sales rank) in the decision-making process when products received higher average ratings and lower variance ($\beta_{\text{price}} = 0.198$ and $\beta_{\text{sale.rank}} = 0.203$, see Table 3). Similarly, when products received higher average ratings and higher variance ($\beta_{\text{price}} = 0.219$ and $\beta_{\text{sale.rank}} = 0.221$, see Table 4). Thus, there is difference that combined effect greatly influences on decision-making when the variance of the ratings distribution is high. The notable different results emerge only when the variance of the ratings distribution is high for one of the products which both received similarly high average ratings and market consists of the prestige-seeking loyal customers.

In contrast to Sun [31], a higher variance of ratings isn't always having a negative effect on demand when the product received a higher average rating. The effect of the higher variance becomes ineffective where the consumers put more weight on prestige-seeking intentions in the decision-making. It is that consumers' decision-making process is fully influenced by their prestige-seeking intentions (see Boven [5]). It is, if and only if the market consists of the loyal customers and the prestige-seeking intentions are the factor in the decision-making process.

When the product received a higher average rating and a lower variance, the perceived quality reaches a threshold from consumers perspective that most consumers are interested in the product, which the finding rationale put forth by Sun [31]. Consumers possibly use the average rating and variance when products' information is difficult to observe. Accordingly, the lower variance couples with the lower average rating to signal low-quality product, which negatively influences the consumers' decision-making.

5. Conclusion

The study explores a new role of the variance of ratings in both sellers' and consumers' decision-making. It constructed a simple game theoretical model to analyze whether the combination of the average ratings and the variance of ratings play a different role in consumers' decision-making process, which depends on the existence of different preference customers (quality- and prestige-loyal) in the market. The findings are as follows: For the product with a higher average rating, a higher variance signals the low

quality of the product by showing that the product meets only prestige-loyal customers' needs. It results in increased price, demand and profit. For the product with a lower average rating, a higher variance signals that perfect-matched quality-loyal customers and a few prestige-loyal customers still love the product although in its low quality. It results in increased price, demand and profit. For the product received a higher average rating, a lower variance confirms high quality of the product by signaling that both prestige-loyal and quality-loyal customers love the product, which in turn increases price, demand and profit. For the product received a lower average rating, a lower variance confirms low quality of the product by signaling that the product has only unsatisfied quality-loyal customers, which in turn decreases price, demand and profit. Consequently, the result of price and demand change is applicable for the customer groups defined with the given model. Overall, consumers show higher intention of consuming low quality of the product with a higher variance, which results in increases price, demand and profit. Therefore, the study demonstrates how consumers' willingness to continue purchasing a potentially risky product with a higher variance when choosing between two products with similar average ratings. The results show that the combination of the average rating and variance of ratings is an important additional factor in assessing the effect of product ratings in consumer's and sellers' decision-making process when the market is consisting of the loyal customers.

The findings have important implications for managers that how to use the variance of ratings more effectively in the case of the existence of different types of customers. The findings suggest that a higher variance should get enough attention by the business owners who would be able to determine what different customer groups' needs are, and offer fitting product. They can develop a profitable pricing strategy, and offer product that is at an acceptable quality level from their customers' perspective. This is especially important for managers to keep a loyal customer base and attract new customers. However, the variance effect cannot be ignored in the consumer decision-making process. Consumers use it to obtain more detailed information from ratings whether the product's quality is high or low and learn the preference of product's prior customers. Therefore, managers should enable more consumers to consider the variance of ratings as well as its contribution with average rating such as information sources in their decision-making process. This causes a reduction in information asymmetry and uncertainty in consumers purchase decisions.

The results show more potential for future research. The study investigates the combination of the average rating and variance of ratings that are given by the loyal customers and hold customers' different preferences towards the product. Zhang et al. [33] found that customers' product evaluations are associated with their consumption goals bias. On the other hand, Bjerjing et al. [4] found that the experiences and opinions of other consumers who have different purposes in product's reviews that cause to increase the ability of consumers to evaluate the product prior to purchase. This is an interesting direction for future research might explore whether a higher variance have the same influence on consumer decision-making process if the loyal customers' buying purposes change in different preferences. Further, previous studies used a product to analyze which

could be considered high risk. Sun [31] used data on books to analyze the combined effect of the average rating and the variance of ratings in the consumers' decision-making process. The author found that a higher variance positively influences consumers' purchase intention. Future research could look at the effect of the variance in consumer's decision-making in the existence of the loyal customers with different preferences extent into the products differentiated according to hedonic and utilitarian attributes. Because, customers' risk attitude would change towards involving product's attributes while central economic-utilitarian concept of low-prices, and a hedonic-festive element arises as an essential attribute of the consumer's behavior (see Gerhard et al. [15]).

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