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Statistical Analysis and Data Visualization
Project Work

Understanding Impact of Product Quality Perceptions on Smartphone Purchase Behaviors

Business Question

Quality is one of the key parameters for building a competitive advantage in the marketplace. Perceived quality's relevance has been confirmed through PIMS-and other studies, which have supported its role as a significant driver of a firm's profitability and of successful corporate performance. Studies have shown that changes in quality perceptions were positively related to stock returns over and above current-term accounting measures (Mizik and Jacobson 2004). Therefore, perceived quality as a long-term driver of business performance represents a very relevant piece of information for both managers and investors alike.

While theoretical conceptualizations of product quality unanimously stress its multidimensional nature, still today no product quality scale, consistent with these multi-dimensional conceptualizations, exists. Therefore product management of a major smartphone producer set-up a project to develop a framework to measure product quality of smartphones as experienced by customers, "Customers' Evaluated Product Quality (CEPQ)", in terms of its constituent dimensions. Another reason to try to develop

a better understanding of customers' product quality perceptions, were the disappointing results of customer satisfaction studies.

The satisfaction surveys conducted by the company have over the years shown only marginal differentiation across competitors and worse were not able to predict repurchase behaviour of customers. That is customers who indicated high satisfaction rates with their current smartphone were not necessarily repurchasing the same smartphone brand, when they replaced their current smartphone. Most importantly product management wants to get a deeper understanding about which quality dimensions significantly explain key outcome variables such as willingness to pay premium (WTPP) and repurchase intentions (RI). Another stakeholder interested in the results of this project is the operations management department of the company. In the past total quality management programs, had difficulties in proving their efficacy. Indeed across industries the frequent failure of TQM programs even from companies, who have been recipients of quality awards, have raised general concerns about their efficacy. One of the likely reasons for the disappointing results of many TQM-programs which has been proposed by quality experts is that "firms do not measure quality effectively" (Sebastianelli and Tamimi 2002, p. 442). Therefore the operations management department hopes that the project provides them with a criterion variable to assess success or failure of their quality improvement initiatives.

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Background on Product Quality

In a first-step of this research project the project team conducted a literature research on product quality. Many authors have stressed the difficulty of defining and measuring product quality. Pirsig (1974, p. 185,213) captured this difficulty of defining the concept of quality among researchers in his famous quote: "Quality is neither mind nor matter, but a third entity independent of two....even though quality can not be defined, you know what it is". A key reason for the difficulty in defining quality is caused by the different perspectives on quality which are rooted in different disciplines e.g. according to the user-based approach of marketing quality is the extent to which a product or service meets or exceeds customer expectations. In contrast, the manufacturing-based approach with roots in operations and productions management defines quality as a conformance to design standards and specifications (Garvin 1988). Ultimately, however, the success of quality improvement programs will be reflected in the beliefs that consumers have about the quality of products (Garvin, 1988). Since consumer behavior is driven by their perceptions of product quality rather than any objective measures such as e.g. conformity with engineering standards, there is a clear need for a more precise measure of perceived product quality. Thus, for the research project at hand, the project team follows the user-based perspective on product quality and accordingly defines perceived product quality as the customer's judgment of the overall excellence, esteem, or superiority of a product (with respect to its intended purposes) relative to the alternative products (Netemeyer et al. 2004).

Multidimensionality of Quality Perceptions

Researchers have conceptualized both the quality of products and services as multidimensional constructs (Garvin 1984, Parasuraman et al. 1988). Unfortunately in contrast to the rich literature on service quality, where instruments to measure service quality (e.g. SERVQUAL and, SERVPERF) have been extensively discussed and

improved in the academic literature (Cronin Jr and Taylor 1992, Zeithaml et al. 2002), and have been widely applied in business practice and adapted to various contexts no comparable multi-dimensional metric exists for products. In the literature, agreement exists that perceived product quality needs to be conceptualized as a multidimensional construct (Brucks et al. 2000, Garvin 1988, Golder et al. 2012, Stone-Romero et al. 1997). However, disagreement exists concerning the number and nature of the constituting dimensions of product quality. Table 1 shows the various quality dimensions proposed in the literature and their definitions.

Table 1: Quality Dimensions and their Definitions in the Literature

Aesthetics/Appearance	
Garvin David A. (1988), Managing Quality, The free press, New York	How a product looks, feels, sounds, tastes or smells – clearly a matter of personal judgments and a reflection of individual preferences – very subjective
Durability	
Garvin David A. (1988), Managing Quality, The free press, New York	A measure of product life – the amount of use one gets from a product before it breaks down and replacement is regarded as preferable to continued repair (has technical and economic dimensions)
Brucks, Zeithaml, Naylor (2000)	Involves the length of time the product lasts, the length of time the product works properply (i.e whether the product needs frequent servicing), how well the product holds up under adverse conditions such as weather heavy use or misuse.
Ease of Use	
Brucks, Zeithaml, Naylor (2000)	Involves the consumer's ability to start and operate the product as well as clarity of instrumentation and instructions – focus groups considered ease of use as an important dimension of quality

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Features/Versatility	
Garvin David A. (1988), Managing Quality, The free press, New York	The bells and whistles of a products, those secondary characteristics that supplement the basic functioning of the product.
Brucks, Zeithaml, Naylor (2000)	The number and complexity of the characteristics that distinguish the model or brand from a stripped-down model. **The bells and whistles generally enable the product to perform more functions**.
Materials	
Guru & Paulssen (2020)	The materials used in the making of product and their quality impacts the overall perception of product quality.
Performance	
Garvin David A. (1988), Managing Quality, The free press, New York	Primary operating characteristics of a product e.g. for an automobile acceleration, handling, crusing speed and comfort.
Brucks, Zeithaml, Naylor (2000)	How well the product does what it is supposed to do – might well be multidimensional itself – e.g for cars power, comfort,safety – must perform well and must do so consistently. This consistency can be referred reliability or dependability
Reliability/Flawlessness	
Garvin David A. (1988), Managing Quality, The free press, New York	Reflects the probability of a product's malfunctioning or failing within a specified period of time – can be measured with mean time to first failure (MTBF)
Serviceability	
Garvin David A. (1988), Managing Quality, The free press, New York	The speed, courtesy, competence and ease of repair –the elapsed time before service is restored, the timelines
Brucks, Zeithaml, Naylor (2000)	Involves the consumer'sease of obtaining repair service (access to service centers and/or ease of self service), the responsiveness of service personnel and the reliability of the performed service

Researchers have moreover questioned whether some of the dimensions proposed in the literature are really distinct i.e. reliability and durability or performance and features (Brucks et al. 2000).

Research Approach

Due to the doubts and inconsistencies, concerning the role of constituting dimensions of perceived product quality in the literature a necessary first step in the present research project is to identify relevant product quality dimensions from a customer point of view. Therefore in a first step qualitative interviews with customers were conducted. The sample consisted of 25 customers both in the USA and in India. Screening criteria for respondents were that they must have been using their smart phones for a minimum period of 6 months. Based on the outcomes of qualitative interviews an initial pool of 40 items to measure quality perceptions and potentially underlying dimensions were developed. In a first step, five practitioners from operations management and six practitioners from marketing, familiar with the quality topic, assessed this initial item pool for content validity and items individually for their comprehensibility. In a final survey 24 items to measure perceived product quality were retained.

Overall 1000 smartphone customers in the US participated in a longitudinal survey which collected data in two waves separated by six months (*data collected in 1st wave*

has a ***_1 suffix*** *and data collected in 2nd wave has a* ***_2 suffix*** *in the variable names*) :

In both the surveys, the first part collected detailed information about the product (brand and exact model), usage frequency, purchase date and purchase price. The second part consisted of the refined item pool to measure customers product quality perceptions. In this section, respondents were asked to evaluate their product on the 24 retained quality questions (in the next page) after the following introduction: “Please evaluate your smartphone in comparison with other smartphones in the same category by answering the questions below. Respondents rated their product on a 5-point scale. Depending on the questions three sets of scale labels were employed ranging from 1 being “very poor”/”very short”/”very low” to 5 being “very good”/” very long”/”very high”. In the third part of the questionnaire, participants answered to a set of questions about themselves and their relationship with the product and its manufacturer. This part consisted of items from established scales for the following concepts: satisfaction, overall perceived quality, willingness to pay price premium, and repurchase intentions. The last part of the questionnaire was used to collect demographic information of the participants.

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Smartphone product quality questionnaire items

qd_pf1	the overall performance of my smartphone
qd_pf2	how well does your smartphone perform its core functions?
qd_pf3	the call quality offered by my smartphone is
qd_ft1	the number of additional features my smartphone offers is
qd_ft2	the innovativeness of the extra features offered by my smartphone is
qd_ft3	the excitement I get from my smartphone's extra features is
qd_as1	the appeal of my smartphone 's design is
qd_as2	the overall attractiveness of my smartphone is
qd_as3	the overall fit and finish of my smartphone is
qd_sr1	the competence of my smartphone's customer service staff is
qd_sr2	the responsiveness of my smartphone's customer service staff is
qd_sr3	the promptness with which my smartphone's customer service reacts to my issues is
qd_re1	the severity of defects/glitches of my smartphone is
qd_re2	my smartphone's probability of failure or malfunctioning is
qd_re3	the time span for which my smartphone runs/will run without any major defects is
qd_du1	durb - the life span of my smartphone is/will be
qd_du2	the amount of time for which my smartphone works/will work perfectly even under heavy usage (ex. frequent gaming) is
qd_du3	the amount of time for which my smartphone maintains/will maintain its full functionality even under harsh usage conditions (extreme cold/heat/rain) is
qd_eu1	my experience to learn how to properly operate my smartphone with all its functionalities is/was
qd_eu2	my user experience with the various functions my smartphone offers is/was
qd_eu3	my smartphone's ease of use is
qd_mt1	the exclusiveness of the materials used in my smartphone is
qd_mt2	the endurance of the material used is
qd_mt3	the robustness of the material used is

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Question on the Efficiency of New Measure

Though the CFO of the firm is all good with encouraging this new measure of product quality, but considering the research cost involved, he wants to make sure a comparative study is taken which justifies if adopting this new measure of product quality even makes sense ofr not?

Thanks to his initiaves , the survey apart from measuring quality conception in its new way, also includes an old single item per dimension measure as well as the ACSI survey which they been using for the last 10 years.

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Tasks:

You and your team members in the Marketing Anaytics division are assigned the task of analyzing this longitudinal data from the survey outlined above. Your team is supposed to help company in understanding the customers' view of product quality for smartphones and how these quality perceptions drive their customer behaviors like repurchase intentions and willingness to pay premium compared to customer satisfaction and other old quality matrix and ACSI index.

Using your knowledge of R and Python-programming your teams needs to do the following:

Since this is a longitudinal survey, you have a strong data to compare the cross-sectional and longitudinal behaviors and suggest your company for a better quality improvement decisions. **In cross sectional analysis you wil compare the independent variables from wave 1(and 2) with the dependent variables of wave 1(and 2) whereas in longitudinal analysis you will compare the independent variables from wave 1 with the dependent variables of wave 2.**

1. Start by analyzing and cleaning the data and getting the descriptives of all the data variables.
2. Create new variables for dependent variables: satisfaction (sat), willingness to pay(wtpp), repurchase intentions (ri) and word of mouth (wom), performance, feature. Etc.
   These new variables are supposed to be means of the items in each of the survey i,e, SAT1 = mean(sat1_1, sat2_1, sat3_1) and so on.
3. Run a regression analysis with the quality dimensions and satisfaction as independent and the mean score of willingness to pay premium and repurchase intention as dependent variables. Interpret your results from a managerial perspective. You need to do a cross-sectional regression for both the waves and one longitudinal analysis for better understanding.

   Do the results of the regression analysis for repurchase intentions differ across brands e.g. Samsung versus Apple. What do the results of these regressions imply? Please compare the brands on these regression

coefficients. What are points of parity and points of difference for the Apple and Samsung.

(for Wave 1 on Wave 1 data use R, and for Wave2 on Wave 2 data use Python)

4. Run a cross-sectional and longitudinal regression analysis with the quality dimensions of the old measure (q_old_XXX) and satisfaction as independent and the mean score of willingness to pay premium and repurchase intention as dependent variables. Interpret your results from a managerial perspective. **Do the results of the regression analysis for repurchase intentions differ and give different perspectives compared to the multi-dimensional measure adopted in question 3?** Please compare the brands again on these regression coefficients. What are points of parity and points of difference for the Apple and Samsung.
5. Using ACSI measure as your independent variable and WTPP and RI as dependent variable for both the waves, conduct a linear regression.

   Is ACSI alone giving you enough idea about the customer behavior?

6. Does the age of consumer plays any role in defining their quality perception?

For question 4,5 and 6, you can use either R or Python as per your choice.

Present your business report to the board of directors including the CFO about your research and if it makes sense to go for the new measure of product quality and if it is really useful compared to the existing measure of customer behavior.

Use data visualization techniques from R and Python to create graphs wherever necessary and helps in ease of understanding.

A well documented and commented R/Python as annexure script file containing details of all the codes employed performing these tasks.

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