Case Study 2: Factor Analysis
Prof. Dr. Marcel Paulssen

_____

Understanding Quality Perceptions of Smartphones

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.

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 properly (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

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**.

Conformance	
Garvin David A. (1988), Managing Quality, The free press, New York	Degree to which a product's design & operating characteristics meet pre-established standards.

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, cruising 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's ease 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

Distinctiveness/Prestige	
Stone-Romero and Stone (1997) Brucks, Zeithaml, Naylor (2000)	Distinctiveness. Another intangible that stems from having a high **quality product** is the **product's** capacity to enhance the status of its possessor through its distinctiveness, uniqueness, and luxuriousness. Prestige involves some visible inherent characteristics of the products such as appearance but also a less tangible social component that is reflected in the product's brand image- fulfilling symbolic needs for self-enhancement

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 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 smartphones 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 33 items to measure perceived product quality were retained.

Overall 1014 smartphone customers in the US participated in the survey: 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 33 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 products 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") or a 7-point scale (labels were from 1 being "Strongly disagree" to 7 being "Strongly agree"). 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.

Smartphone product quality questionnaire items

1. the overall attractiveness of my smartphone is
2. my smartphone consistently performs
3. my user experience with the various functions my smartphone offers is/was
4. my smartphone is really unique
5. the performance of my smartphone is excellent
6. the innovativeness of the extra features offered by my smartphone is
7. the overall performance of my smartphone is
8. the extra features offered in my smartphone usually function
9. the competence of my smartphone's customer service staff is
10. the appeal of my smartphone's design is
11. my experience to learn how to properly operate my smartphone with all its functionalities is/was
12. how well does your smartphone performs its core functions
13. my smartphone's ease of use is
14. the promptness with which my smartphone's customer service reacts to my issues is
15. the endurance of the materials used in my smartphone is
16. the functioning speed of my smartphone (i.e. time taken to turn ON/OFF, open apps, multi-task etc) is
17. the robustness of the materials used in my smartphone is
18. the excitement I get from my smartphone's extra features is
19. the level of professionalism shown by the service staff is
20. the look- and feel of my smartphone is
21. the accessibility of my smartphone's customer service is
22. the severity of defects/glitches of my smartphone is
23. my smartphone is a prestigious item for me
24. the responsiveness of my smartphone's customer service staff is
25. the number of additional features my smartphone offers is
26. the time span for which my smartphone runs without any major defects is
27. the overall fit and finish of my smartphone is
28. the amount of time for which my smartphone works perfectly even under heavy usage (ex. everyday usage) is
29. the frequency of defects/glitches of my smartphone is
30. the usability of my smartphone is
31. the life span of my smartphone is
32. the standard of materials used in my smart phone is
33. my smartphone's probability of failure or malfunctioning

Exercise:

You are in charge of analyzing the data from the survey outlined above. Please conduct the following analyses and answer the respective business questions.

1. **Orthogonal Factor Analysis**: Run a factor analysis with the quality items qd_1 to qd_33. In this first step run a principal axis factoring and use varimax rotation. Go through the steps of a factor analysis that you have learned i.e. start with looking at the correlation matrix, check whether the data set and all of its variables are suitable for factor analysis etc. Make appropriate decisions and decide on a final factor solution. Interpret the factors based on the literature review on quality dimensions (see table 1). **Develop a report i.e. in html of your key results and justify the choices you made in the course of the analysis.** Do all of the variables in your final solution show clear loading patterns? For your final solution run a principal component analysis and compare the results. Are there differences to your solution based on principal axis factoring? What do the eigenvalues of the factors/quality dimensions tell us about their relevance for repurchase behaviour? Please explain!

2. **Oblique Factor Analysis:** Run an oblique factor analysis with the variables of your final solution in exercise 1 using Promax. How high are the factors correlated and what is the highest correlation between factors. What does this mean – please explain. Compute factor scores for your factors and name and label them appropriately. Compute mean scores for the three willingness to pay premium items (wtp1-wtp3) and the two repurchase intention items (ri1-ri2). Run a regression analysis with the factor scores of the quality dimensions as independent and both 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 across brands e.g. Samsung versus Apple versus LG. What do the results of these regressions imply? Please compare the brands on the factor scores. What are points of parity and points of difference for the different brands. **Develop a report of your key results**.

References

Brucks, M., Zeithaml, V.A. and Naylor, G.(2000), "Price and brand name as indicators of quality dimensions for consumer durables", Journal of the Academy of Marketing Science, Vol. 28 No. 3, pp.359–374.

Cronin Jr, J.J. and Taylor, S.A.(1992), "Measuring service quality: a reexamination and extension", Journal of Marketing, Vol.56 No.3,pp.55–68.

Garvin, D.A.(1984), "What Does 'Product Quality' Really Mean?", Sloan Management Review, Vol.25 No.1 pp.25-43.

Garvin, D.A.(1988), Managing Quality: The Strategic and Competitive Edge, Simon and Schuster.

Golder, P.N., Mitra, D. and Moorman, C.(2012), "What is quality? An integrative framework of processes and states", Journal of Marketing, Vol.76 No.4, pp.1–23.

Mizik, N., & Jacobson, R. (2004), "Stock return response modeling", Assessing marketing strategy performance, pp 29-46.

Netemeyer, R.G., Krishnan, B., Pullig, C., Wang, G., Yagci, M., Dean, D., Ricks, J., et al.(2004), "Developing and validating measures of facets of customer-based brand equity", Journal of Business Research, Vol.57 No.2, pp.209–224.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L.(1988), "SERVQUAL: A Multiple-Item Scale foR Mesuring Consumer Perception of Service Quality", Journal of Retailing, Vol.64 No.1, pp.12–40.

Pirsig, R.M.(1974), Zen and the Art of Motorcycle Maintenance: An Inquiry into Values, Random House

Sebastianelli, R. and Tamimi, N.(2002), "How product quality dimensions relate to defining quality", International Journal of Quality & Reliability Management, Vol.19 No.4, pp.442–453.

Stone-Romero, E.F., Stone, D.L. and Grewal, D.(1997), "Development of a multidimensional measure of perceived product quality", Journal of Quality Management, Vol.2 No.1, pp.87–111.

Zeithaml, V.A., Parasuraman, A. and Malhotra, A.(2002), "Service quality delivery through web sites: a critical review of extant knowledge", Journal of the Academy of Marketing Science, Vol.30 No.4, pp.362–375.