Developing a Key Index, Bootstrapping Confidence Intervals, Sample Size and Measuring Service Performance

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Abstract

This paper focuses on quantifying customer perceptions of service performance by developing a Key Performance Index (KPI). We develop a KPI suitable for use in service enterprises from the process capability indices used in the manufacturing industry. A bootstrapping method is used to construct KPI confidence intervals with a coverage probability to evaluate the reliability of the bootstrap confidence interval. Simulation results indicate that higher confidence and service levels require larger sample sizes. A table of the required sample sizes is constructed under various combinations of service and confidence levels for managerial reference in service enterprises. Our KPI allows managers to evaluate the actual service level delivered within each of five SERVQUAL categories and derive tolerance levels for each. To demonstrate the usefulness of our proposed KPI, an example from Taiwan's motel industry is used to chart the correlation of KPI to customer service dimensions, confidence interval, and actual service delivered.

INTRODUCTION

Research Background and Objectives

In recent years, the value produced by service industries has become a main source of social wealth, and has exceeded the corresponding wealth generated by manufacturing industries in most advanced countries. Job opportunities and the creation of wealth in the service sector show continuous growth in these countries. More important, however, is the concept now prevalent in marketing theory that customer satisfaction is based on the quality of interaction while procuring a product or service as well as product life. This concept puts all business activity in the arena of service quality, since business activity is the exchange of intangible goods as well as, but not exclusively, tangible goods regardless of the product being sold. Hence, it is timely to introduce a quantitative method for measuring the quality of these customer perceptions through a Key Performance Index or Indicator (KPI). Using the highly successful methods of product quality control, we propose a method for service quality control.

A significant amount of research has been carried out since service quality concepts were introduced by Gronroos in 1982. In most surveys done on service quality, the difference between customer expectation and perception is called GAP5 based on Parasuraman’s model (Parasuraman, Zeithaml, and Berry 1985). Researchers generally use a t-Test or the Mann-Whitney test to determine whether GAP5 is zero or not. In view of the unique characteristics of service quality, we combine this concept with a non-normal unilateral index from the manufacturing industry to evaluate GAP5. We also propose that the performance of various service enterprises can be evaluated by such an index.

In this paper, first we examine the evolution of Process Capability Indices used in manufacturing to design a KPI for the service industry. Then, we employ a bootstrap method to construct the performance confidence interval. The coverage probability is used to evaluate the index reliability. From the interval estimation managers using our KPI can immediately evaluate the performance of their service. Also the sample size required for measuring service quality can be determined. Finally, we develop a realistic example from the Taiwan hotel industry using the five dimensions of the SERVQUAL model (Parasuraman, Zeithaml, and Berry 1988). In GAP5 the difference between customer service perception and his service expectation is analyzed. Since data may range from normal to non-normal distributions in each of the five dimensions, the estimated KPI and its confidence limits are calculated based on their underlying distribution. We further demonstrate that service quality problems can be detected easily by using appropriate diagrammatic means.

DESIGN METHODOLOGY

Evolution of Service Quality Analysis: PZB and the SERVQUAL Model

Service has three characteristics: intangibility, heterogeneity, and inseparability. When purchasing goods, the consumer employs many tangible cues to judge quality: style, hardness, color, label, package, and fit. When purchasing services, however, fewer tangible cues exist. In most cases, tangible evidence is limited to the service provider’s physical facilities, equipment, and personnel (Parasuraman, Zeithaml, and Berry 1985).

The PZB model was developed by Parasuraman, Zeithaml, and Berry in 1985. This model consists of five gaps where enterprises fail in meeting both internal and external expectations. GAP1 to GAP4 reflect the service marketer's internal patterns and potential deficiencies, while GAP5, which will be our focus, represents the gap perceived by the customer, the difference between his expectation and perception of a given service.

Although there are various types of service quality tests, the SERVQUAL instrument, also developed by Parasuraman, is widely used in the service industry. Parasuraman's research reveals that a consumer's assessment of service quality fits into ten potentially overlapping dimensions. These dimensions are tangibles, reliability, responsiveness, communication, credibility, security, competence, courtesy, understanding or knowing the customer, and accessibility. To simplify these ten dimensions Parasuraman, Zeithaml, and Berry (1988) removed the items with relatively low item-to-total correlations and developed a refined scale with 22 items spread over the five dimensions listed below.

Development of the Key Performance Index (KPI)

As can be seen from Table 1 and Figure 1, GAP5 depends on customers' expectations and perceptions. Since the distance between expectations and perceptions will determine customer satisfaction, a customer's perception of service quality will have a direct bearing on enterprise performance. In Parasuraman's Model, by reducing Gaps 2, 3 and 4, Gap 5 will be reduced. Hence, when customers' perception of service is higher than their expectation, we expect a positive response to the service experience. On the other hand, if customers' perception of service is lower than their expectation, we would expect a negative response to the service experience.

For our purposes suppose that A = customers' adequate service, P = customers' perceptions, and $GAP = P - A$. The larger this GAP, the better the enterprise performance will be since customer perception will outstrip his expectation. But if the expectation is higher than the perceived performance, then this GAP will be negative.

Now we re-introduce the non-normal process capability index proposed by Clement (1989) which uses percentile ranges to establish C_p and C_{pk}. In the manufacturing case, it is common to set the percentile q =.135 and $1-q$ =99.865, which gives a percentile range equivalent to 6σ, the 6 Sigma standard. The range can be appropriately adjusted given the sample data while d, the semi-distance between the upper and lower spec limits, is also adjustable and depends on the specification limits.

$$C_p^{'} = \frac{USL - LSL}{\xi_{1-q} - \xi_q} = \frac{2d}{\xi_{1-q} - \xi_q}$$

$$C_{pk}^{'} = \min\left(C_{pu}^{'},\ C_{pl}^{'}\right) = \min\left(\frac{USL - M}{\xi_{1-q} - M},\ \frac{M - LSL}{M - \xi_q}\right)$$

Combining Parasuraman's concept with Clement's non-normal process capability index for the unilateral specification used above where the *GAP* is "the larger the better," we propose a Key Performance Index based on the C_{pk} lower spec limit, LSL, above. It is defined as follows:

$$KPI = \frac{M_{GAP} - L}{M_{GAP} - \xi_{GAP}(q)},$$

where M_{GAP} is the median of *GAP*, $\xi_{gap}(q)$ is the q_{th} percentile of *GAP*, and *L* is minimum tolerance of the GAP, our lower specification or tolerance limit for the *GAP*. In other words, we expect that the *GAP* should not be smaller than *L* when evaluating the enterprise performance. The value of *q* will depend on an enterprise's target service level or its service objective. For instance, when the service objective is set such that the perception of 95% of customers will be greater than *L*, the minimum desired service value, *q* is set to 0.05 such that *1- q* is 0.95.

When *KPI* = 1, then $\xi_{gap}(q)$ = *L*, the desired level of performance. Hence, if $(1-q)\%$ of the *GAP* is greater then *L*, then *KPI* is greater than 1. Conversely, when the *KPI* is lower than 1 the enterprise does not meet its minimum desired service level, which is consistent with the process capability index used in manufacturing.

CONCLUSION

In this paper we have developed a Key Performance Indicator based on capability indices widely used in manufacturing for quality control. In particular, we used Clement's non-normal process capability index with a unilateral specification. To this we applied Efron's bootstrapping method to determine sample size and a confidence interval. Finally, Parasuraman-style dimensional data was tested in 400 parametric Beta simulations using the Kolmogorov-Smirnov test to approximate the non-normal distribution of the data.

Managerial Implications

We then applied this KPI to SERVQUAL data using Parasuraman's five dimensions to determine its managerial efficacy. Given the distribution median of the data and the factor loadings of the survey, our KPI could be applied to any desired service level, a managerial target, and to the customer's expectation of an adequate service level. In the example give we used L = 0, that is, the customer's minimum expectations were meet, to demonstrate the variance of actual service performance levels given 90% and 95% service target levels. Our KPI performed well in this regard. Also by using the KPI 95% confidence interval a manager can discern not only if the desired service level has been achieved, but also where in that tolerance band service is actually being delivered. Hence, we believe our Key Performance Indicator is a practical decision-making tool for the service industry. Therefore, we conclude that since the capability index approach has been very successful in the manufacturing industry, its application to the ever expanding service industry is a step towards quantifying the dimensions of service quality. This research can be extended to almost any industry that surveys its clientele and it is especially well suited to Likert data that can be reduced by factor analysis. Various modifications could be made including sensitivity studies, by varying *A* and *L*.

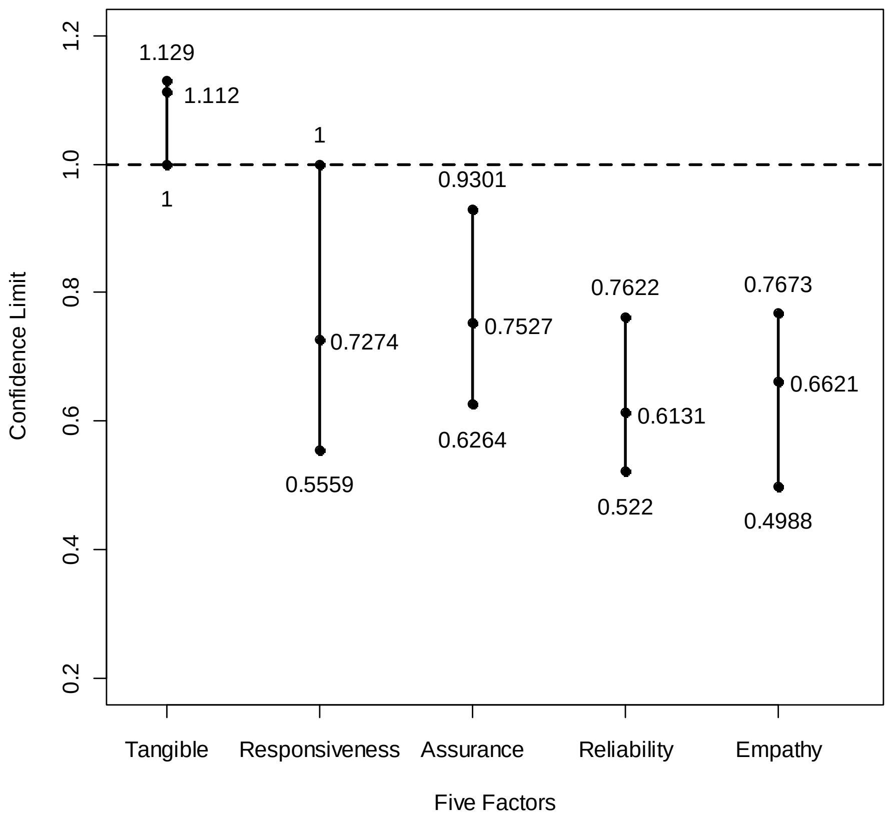

Figure 6: Estimated KPI and Its Confidence Limit for the 5 Dimensions Under a 90% Service Level.

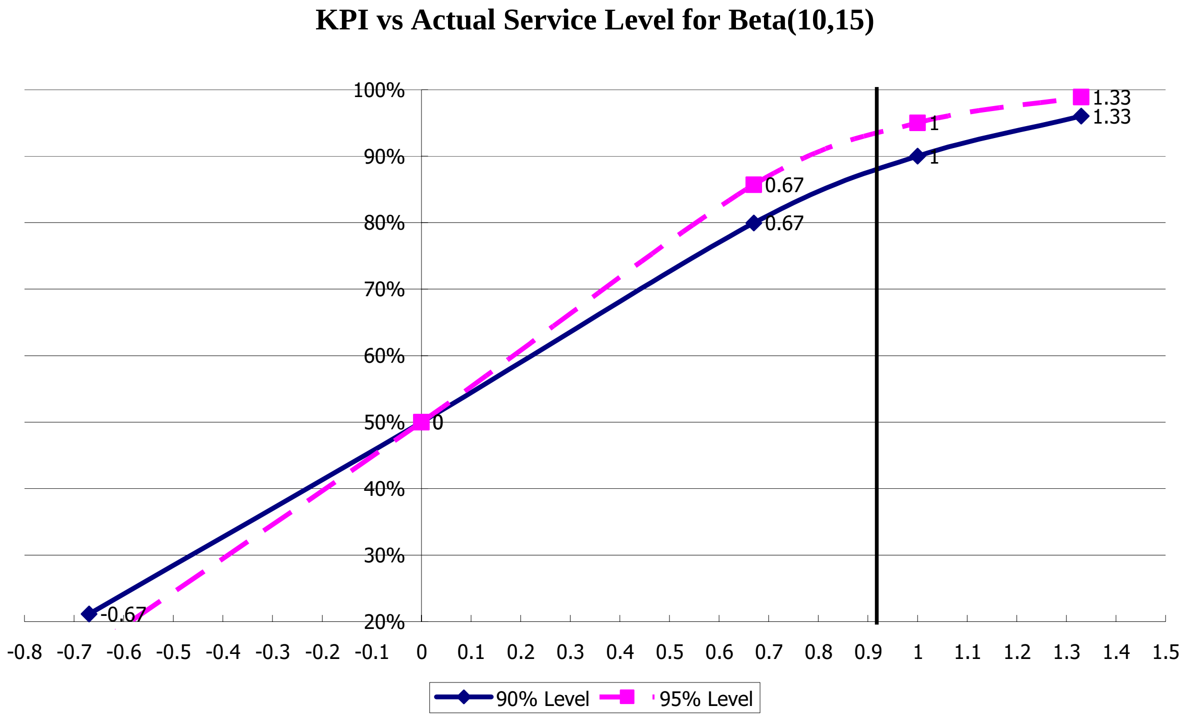

Figure 8: Beta (10, 15) with KPI and Actual Service Level for 90% and 95% Desired Service Levels

At the 50th percentile KPI = 0, while it is 1 at the target value. The Key Performance Indicator is also likely asymptotic to the 100% Actual Service Level, but we offer no proof here.