An Approach to Prioritize Customer-Based, Cost-Effective Service Enhancements [#]

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Abstract

We propose an approach to prioritize service improvements based on the twin objectives of higher customer value and lower cost. The approach involves (1) conducting qualitative customer studies to identify a list of possible service improvements, (2) conducting a quantitative, conjoint-like survey to determine values customers attach to each of the improvements, (3) collecting data on the costs of making the service improvements, and (4) putting the data in (2)–(3) together to prioritize improvements using a "bang for the buck" rule. The approach also allows for maximizing the likely increased service usage resulting from any subset of service improvements subject to a budget constraint. We illustrate the proposed approach in the context of improving passenger train service between a pair of cities in India. An adaptive self–explicated approach is used for obtaining customer values and cost estimates. The customer values so elicited display substantial face validity.

Keywords: Service enhancement, Service quality improvement, Customer preferences, Survey research, Knapsack problem

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Changing customer preferences, improved competitive offerings, and emergence of new technologies often drive firms to introduce new services and improve existing service offerings. New service offerings that are timely and responsive to user needs are also developed to remain competitive (Kelley and Storey, 2000). Because of their lower costs and risks, service enhancements are undertaken more frequently as compared to new service introductions (Berry and Lampo 2000). Service enhancements increase the loyalty of existing customers, thereby increasing the share of business they do with the firm (Storey and Easingwood 1999). They also help in attracting new customers thus serving the dual purpose of attracting new customers while retaining existing ones.

In practice, managers identify opportunities for service improvements through a survey of customers' perceptions regarding various aspects of service including quality (Parasuraman et al. 1985; Cronin and Taylor 1992, 1994) and follow it up with a cross functional analysis involving marketing, human resources, finance, and operations before implementing the changes (Bolton and Drew 1991, Collier 1991, Schneider and Bowen 1984, 1993). Therefore, marketing's desire for service enhancements needs to be balanced by considerations of cost, capabilities of personnel, availability of resources like facilities and technology, and the impact of the improvements on other organizational functions. In a recent paper on the research priorities for service science, Ostrom et al. (2010) have reiterated the need for an interdisciplinary lens to address service development priorities for stimulating innovation, enhancing service design, and optimizing value.

There is limited research on analytical methodologies to help managers make the trade-offs while seeking service improvements. Rust, et al. (1995) proposed a "Return on Quality (ROQ)" approach to quality improvement by modeling the relationship between service quality improvement efforts and profitability. They developed a 'chain of effects' model to link improvement effort to improvement in service quality, increased perceived quality, and customer satisfaction. Increased customer satisfaction, in turn, leads to higher levels of customer retention resulting in positive impact on revenue and profit. Soteriou and Chase (2000) suggested a methodology to guide improvements in service while controlling for costs. They adopted robust optimization which considers uncertainty resulting from measurement errors and/or noisy information and demonstrated the approach through an application in a large health care setting. Clare and Peter (2005) developed an analytical hierarchy process for service quality (AHP-SQ) to help managers prioritize service improvements to enhance competitiveness while balancing firm resources. The current research follows in the spirit of the earlier approaches in maximizing the customer value of service enhancements subject to a cost constraint.

Research Approach

Service enhancements, to be successful, need to take into account customer preferences and they should be cost effective thereby maximizing the "bang for the buck". We propose an approach to prioritize service enhancements taking into account customer preferences and estimated costs. The proposed approach involves the following steps:

1. Conduct qualitative customer studies (e.g., one-on-one interviews, focus groups, and ethnographic studies) to identify a list of possible service improvements.
2. Do a quantitative survey of a random sample of customers to determine the values that customers attach to the list of possible service improvements.
3. Collect data from the service provider regarding the cost of implementing the service improvements.
4. Utilize the data from steps (2) and (3) above to provide a prioritized list of cost-effective service enhancements that maximize customer value.

We operationalize the above four-step approach in the context of an application for service improvements for the Indian Railways.

Operationalizing the Research Approach: An Illustrative Application

The Indian Railways passenger train service is one of the largest service providers in the world. It moves 20 million passengers per day (more than the population of Australia!) The recent turnaround in profitability of Indian Railways has been well reported (Kumar and Mehrotra 2009, Musacchio, Khanna, and Tahilyani 2009). The passenger service experience varies across the country so the needed service improvements also vary across the routes served. We chose the daytime, air-conditioned (AC) train travel between the two south-Indian cities of Chennai and Bangalore (approximately 220 miles apart) as the setting for illustrating the proposed approach. The approach recognizes that customers of the service (in this case, train passengers) are the best judges of the value of potential service enhancements. The "cost" data are provided by the relevant service-provider (in this case, officials of the Indian Railways). The approach involved the following steps:

1. Conduct qualitative customer studies (e.g., one-on-one interviews, focus groups) to identify possible service improvements. In our application, a one page questionnaire was administered during train travel to 103 randomly selected passengers soliciting their suggestions for possible improvements in service, e.g., duration of travel, frequency of service, seat comfort, climate comfort, cleanliness, meal services, bathroom services, and ambiance. Each respondent provided up to three suggestions. The more frequently

mentioned suggestions (mentioned by at least three of the 103 respondents) constituted the list of 19 improvements that were studied further.

2. Do a quantitative survey of a random sample of customers to determine the values that customers attach to the list of possible service improvements. We surveyed 222 AC daytime train passengers as they traveled between Chennai and Bangalore (both directions). The survey utilized a state-of-the-art computer based technique known as ASEMAP (Adaptive Self-Explication of Multi-Attributed Preferences, Netzer and Srinivasan 2011) to prioritize the list of service enhancements. The analysis, based on 203 usable responses, provided the quantitative values each respondent places on each of the service enhancements. A novel aspect of the survey is that it was done on the web using laptops while the respondents were traveling between Chennai to Bangalore (both directions). The survey also obtained demographic information on the customers and their current travel habits in the corridor (# of trips in the previous twelve months by rail, air, and road). We also asked questions regarding the intended number of additional train trips under three possible service enhancement scenarios, from a "package" that includes six of the most valuable enhancements for that respondent to one that improved only his/her most valuable enhancement.
3. Collect cost data from the service provider (in this case, from 16 senior managers of the Indian Railways) regarding the cost of providing and the difficulty of implementing each of the service enhancements.
4. Utilize the data from steps (2) and (3) above to provide a prioritized list of cost-effective service enhancements to maximize customer value. A simple analysis would be to rank the enhancements on a "bang for the buck" basis (average value of the improvement to customers divided by the cost of providing the enhancement). The "Knapsack" problem in

Operations Research, viz., maximizing customer preference subject to a budget constraint, provides the logic for the “bang for the buck” rule. A more sophisticated analysis used a Nonlinear Modified Knapsack formulation to determine the subset of service enhancements to maximize increased ridership for a given a cost budget. This approach estimated the relationship between the value of a service enhancement package and the likely increase in train travel for each of the respondents in the sample.

Method

Qualitative Survey. We randomly selected 103 passengers over six train trips in the AC coaches of day trains between Bangalore and Chennai. Based on their responses to the following question - “Please indicate three most important areas for improving your overall travel experience during the train journey” - we created the shortlist of 19 items which were mentioned by at least three of the 103 respondents.

Table 1 About here

Quantitative survey. In the next stage, we needed to obtain quantitative values for the 19 items at the individual respondent level. Among the available methods, the simplest is a rating scale (e.g., 0=Not at all valuable,…, 5=Extremely valuable). The main difficulty with the rating scale is that respondents tend to say that every improvement is highly valuable so that we do not get much variation in value across the items (Netzer and Srinivasan 2011). A Constant-Sum (e.g., allocate 100 points across the 19 improvements) forces respondents to choose, but with 19 items respondents oversimplify the task, e.g., by assigning points only to two or three of the more valuable items and leaving the rest of the items blank. The constant–sum has low validity, especially with a large number of attributes (Srinivasan and Wyner 2009).

Conjoint analysis, developed in the 1970s, is a popular technique used by researchers and managers during the concept development stage of new product development as well as redesign of existing products and services (Green and Srinivasan 1990, Pullman and Moore 1999). It is a decompositional method for measuring customers' preference structures through tradeoffs in multi-attribute products and services. The technique decomposes the preferences for each level of a multi-attribute product or service based on an individual respondent’s overall evaluations of a set of alternatives, pre-specified in terms of levels of different attributes. The Full-Profile method of conjoint analysis and the Choice-Based Conjoint method are suited for small number of attributes but results in severe information overload on respondents for a larger number of attributes (greater than 10). Over the years, several approaches have been developed for handling a larger number of attributes. These include the self-explicated approach, hybrid conjoint analysis, and adaptive conjoint analysis (Green and Srinivasan 1990). The current study utilized a web-based interactive technique known as ASEMAP (Adaptive Self-Explication of Multi-Attribute Preferences) to uncover customer preferences (Netzer and Srinivasan 2011). Data were collected through a wireless connection between laptops in moving trains in India and computer servers located half way around the world, in the U.S. In addition, respondents were given a one page questionnaire related to usage, demographics, and expected increase in train trips if the respondent’s six (three, one) most valuable improvements were implemented.

ASEMAP. The ASEMAP process as it relates to the present application is described below:

Step 1**:** From the list of (19) improvements below, place a check mark on the nine improvements that are more valuable to you:

1. Cleaner platforms
2. Internet with wi-fi access

…

…

19. Shorter travel time

Step 1 helped create two groups of improvements – Group 1 comprising of the more valuable set of 9 improvements for the individual respondent and Group 2 comprising of the less valuable set of 10 improvements.

Step 2**:** The respondent was asked to drag and drop the improvements on the screen (second page of the survey) so that the improvements in Group 1 are ordered from the most valuable (on the top) to the least valuable (at the bottom).

Rank	**Improvement**
1	Cleaner Coaches
2	More Punctual Trains

••••

••••

9	More Comfortable Seats

Repeat this step for the less valuable set (Group 2) of 10 improvements. Combining the rankings from the two groups results in an overall rank order of the 19 improvements.

Step 3: Constant-Sum Paired Measurement of Improvements – The respondent compares pairs of improvements, one pair at a time, and assigns weights adding to 100 to reflect the relative value of each improvement. While 171 paired combinations are possible with 19 improvements ($^{19}C_2 = 171$), the ASEMAP technique permits the estimation of values with a much smaller subset of paired comparisons thus avoiding information overload as well as respondent fatigue.

Figure 1 About here

Suppose two improvements A and B are compared as shown in Figure 1. Let V_A and V_B denote the values attached to improvements A and B. Suppose the respondent indicates that

$V_A / V_B \approx 2$.

Then $(\text{Log } V_A) - (\text{Log } V_B) \approx \text{Log } 2 \approx 0.301$.

Each paired comparison produces such an "observation." When data from a number of overlapping paired comparisons is given, the log values are estimated by multiple regression. The consistency of the respondent's data is assessed by the adjusted R-squared of the multiple regression. By taking anti-logs we get the values, which are normalized to add to 100.

We describe below the adaptive approach of choosing the subset of paired comparisons. More details can be found in Netzer and Srinivasan (2011).

Adaptive measurement of values – Initial step (illustrated for 19 improvements). Suppose we re-number the improvements for this respondent so that the most important improvement is #1, second most valuable is #2, …, the least important is #19. (The ranking was obtained in Step 2.) We start with the three paired comparisons:

- ☐ 1 vs. 19
- ☐ 1 vs. 10 (middle in terms of value)
- ☐ 10 vs. 19
- ☐ Estimate v_1, v_{10}, and v_{19} by log-linear multiple regression of the three paired comparisons above.

Adaptive measurement of values – Subsequent steps. We now have the values v_1, v_{10}, and $v_{19.}$ If we do not obtain any further paired comparisons, we will have to estimate the intermediate values (v_2,…., v_9) and (v_{11}, …,v_{18}) by interpolation. This results in two possible scenarios depending on whether (v_1-v_{10}) is larger than (v_{10}-v_{19}) (Scenario A) or not (Scenario B).

Figure 2 About here

It would seem intuitive that in order to minimize the interpolation error introduced by the dotted lines shown in Figure 2,

- In scenario A determine value of an improvement in the middle of the interval I,
- In scenario B determine value of an improvement in middle of the interval II.

The intuition provided by this example is confirmed in the formula below.

Criterion for selecting the interval to explore. In the example above, there are two intervals, (1 through 10) and (10 through 19). Each interval has a top improvement, a bottom improvement, and one or more intermediate improvements. The maximum possible interpolation error for an interval is shown by the sum of the vertical lines in Figure 3. Intuitively, the maximum possible interpolation error is given by the area of the triangle shown in Figure 3. The result can be proved rigorously.

Figure 3 About here

$$\text{Maximum Possible error} = \left(\begin{array}{c} \text{Difference in value} \\ \text{Between the top and bottom} \\ \text{Improvements} \end{array} \ \mathbf{X} \ \begin{array}{l} \text{\# of intermediate} \\ \text{improvements} \end{array} \right) \Big/ \, 2$$

We illustrate the choice of paired comparisons in the illustration below. To keep the example simple we show only 15 (rather than 19) improvements. The main idea of the adaptive method is to choose at each stage the interval with the maximum possible interpolation error and choose the improvement in the middle of that interval.

Figure 4 About here

In the illustration the bracketed double arrows denote the pairs chosen and the vertical double arrows show the next interval chosen by the maximum possible interpolation error criterion stated earlier. The numbers in Figure 4 are the values of the improvements as estimated up to that point in the estimation procedure. They are scaled in such a way that the numbers together with the interpolated values for the remaining improvements add to 100. Empirical research shows that approximately 13 paired comparisons are sufficient (Netzer and Srinivasan 2011). (Asking a larger number of paired comparisons actually decreases predictive validity possibly because of respondents' fatigue.) After the predetermined number of pairs has been obtained, the log-linear regression estimates the values for the improvements included in the paired comparisons. The values for the remaining improvements are determined by interpolation. The values are normalized to add to 100 thus giving us the values assigned to each improvement, which are unique to each respondent.

Results

Average values of improvements. Out of the 222 respondents, three respondents had incomplete data. An adjusted R^2 =0.5 for the log-linear regression was used as a cut-off for data quality. This results in the deletion of 16 respondents ($\simeq$ 7%) leaving 203 usable respondents. The average adjusted R^2 for the final usable sample of 203 respondents was 0.92.

The average values of the improvements are listed in Table 2.

Table 2 About here

Face validity: The results were checked for face validity by correlating the findings of the qualitative survey (n=103) and the quantitative survey (n=203). The correlation between the frequency of mention of the 19 improvements in the qualitative survey and the mean value for these improvements from ASEMAP is 0.78, thus indicating good face validity.

Benefit segments. The following three benefit segments (based on maximizing the pseudo-F statistic) emerged from our analysis:

- Segment 1 comprising of 42% respondents are “Middle of the road” customers – Their values for the improvements are not too different from each other except for the de-emphasis of “Seating facing each other” which had very little value.
- Segment 2 comprising of 28% respondents are “Cleanliness oriented” – These customers gave higher values for cleaner toilets, coaches, platforms, and better hygiene/quality in food service.
- Segment 3 comprising of 30% respondents are “Safety oriented” – These customers value safety at the stations and in the trains, i.e., less unauthorized persons and less crowded platforms. They also gave higher values for cleaner toilets and shorter travel time.

The benefit segments were obtained to provide an intuitive understanding of the heterogeneity in the population of travelers regarding improvements they considered valuable. However, all subsequent calculations are done with the individual level results. Thus we capture heterogeneity both across segments and within segments.

Cost data from Railways Officials. In general, we need to undertake an accounting study to determine the cost for the least expensive way of making each improvement. However, in this illustrative application, we obtained subjective estimates from railways officials for the prioritization. We followed the same ASEMAP task as that for passengers, but instead of asking them “How valuable is the improvement?”, our question was “How costly and difficult to implement is the improvement?”. Our respondent set included 16 senior managers from Indian Railways, including 2 General Managers, 4 Divisional Railway Managers (DRM), and Heads of Departments (HOD) of Finance & Accounts, Commercial, Operations, etc. This output of this analysis is the relative “cost” of making the improvements which again add up to 100.

By mapping customer values with officials’ cost estimates, we can identify areas for improvement to be taken on a priority basis, i.e., improvements that may be taken up now (shown on the top right quadrant) , improvements that can be taken up later (marked as Do/ Don’t do?), and improvements that could be rejected (bottom left quadrant) . The horizontal and vertical lines are median splits, i.e., half the improvements are above the horizontal line and the other half below the line. Likewise, half the improvements are to the right of the vertical line and the other half to the left of the line. The dotted line indicates the split if additional resources (budget) become available.

Figure 5 About here

“Bang for the Buck”. The “Knapsack” problem in Operations Research (Sahni 1975) was used to help prioritize the improvements. The algorithm maximizes customer preference subject to a cost constraint as shown:

Maximize $\sum V_j X_j$

subject to $\sum C_j \; X_j \leq B$

where

j = 1,2,…19, the improvements

X_j = 1 or 0 (improvement implemented or not)

V_j = Average customer value

C_j = Cost

B = Budget (a number between 0 and 100, where 100 represents the total cost of making all 19 of the improvements) , and

$\sum$ = Sum over the 19 improvements

Had the X variables been continuous, the above optimization is equivalent to

Max $\sum \left(V_j - \lambda C_j \right) X_j$

where λ = Lagrange multiplier.

Then sorting by $\left(V_j / C_j\right)$, the “bang for the buck,” in a decreasing order and choosing the maximum number of improvements from the top of the list so that the budget constraint is satisfied we can solve the optimization problem. The “bang for the buck” methodology helps identify the top improvements that can be implemented to maximize the total value of the service improvements to the customers while satisfying the budget constraint.

Table 3 About here

Likely increase in service usage. Before making the investments for the improvements, the service provider will also be interested in knowing the returns on the investments. In our case, we could estimate the incremental revenues by using the expected additional trips as a proxy for revenues. The expected additional travel could come from customers switching away from other modes of travel, viz. road or air, or possibly increasing overall travel between Chennai and Bangalore. We captured such data by asking respondents to indicate the current annual trips and their intended number of additional trips if that individual’s top six (three, one) improvements were implemented. Figure 6 displays the concave relationship between incremental value of improvements and the intended additional travel trips.

$$\text{Intended Additional Trips} = A^{*}(\text{Incremental Value of Improvements})^{B}$$

Figure 6 About here

We found that the concave relationship of Figure 6 fitted data better (in terms of adjusted R-squared) than an S-shaped relationship.

We used the nonlinear modified "Knapsack" problem to calculate the average intended additional travel.

Maximize $$\sum_i W_i \; f_i\left(IV_i\right)$$

subject to $$\sum_j C_j \; X_j \leq B$$

where $$IV_i = \sum_j V_{ij} X_j$$

i = 1,2,…203, the respondents

j = 1, 2,…19, the improvements

W_i = Weight for respondent i (see below)

IV = Incremental value of the package of improvements

f(IV) = Intended additional travel trips

V_{ij} = Value of improvement j for customer i

B = Budget parameter (to be varied between 0 and 100). The total cost of making all 19 of the improvements =100.

By a package of improvements we mean any subset of the 19 improvements.

An interesting issue in sample weighting arises in our context. Recall that we had polled passengers travelling in trains in the Chennai-Bangalore route. This sampling procedure is ideal in providing a representative sample of travelers besides having the advantages of interviewing them at the time of service when the memory is fresh, and the respondents having some free time at their disposal. However, the sampling procedure has the property that the probability that a customer is included in the sample is proportional to his/her frequency of travel in this route. Such a weighting towards heavy users is desirable from the point of view of Tables 2 and 3 and Figure 5. But it creates a problem when the average intended incremental travel per customer is computed. (By multiplying the average by the total number of customers who use the route we obtain the total number of intended additional trips). The computation of incremental travel uses respondent weights W_i proportional to (1/travel frequency by train), with the weights normalized so that the average W=1. By utilizing the inverse weighting each customer has equal probability of being included in the sample so that we obtain the average intended travel per customer. Of course, the reported base amount of travel and the expected incremental travel are likely to be greater for more frequent travelers and this is automatically taken into account in the computation. Had we not weighted the respondents inversely to the frequency of travel, we would have double weighted the more frequent travelers in computing the average intended additional travel/customer.

As each $X_j = 0$ or 1 and there are 19 possible improvements, the total number of possible packages of improvements = 2^{19} = 524, 288. While the number looks to be large, it is not too time consuming for modern day computers.

The Pareto-Optimal Frontier is shown in Figure 7.

Figure 7 About here

We utilize the following example to illustrate a few Pareto-Optimal Strategies. The selected package consists of the following three improvements:

1. Cleaner toilets and coaches,
2. Internet wi/fi access, and
3. Better quality/hygiene food service.

The “cost” factor for this package is 14. (The cost factor would have been 100 had all the 19 improvements been implemented.)

Average intended additional train travel = 2.06 one-way trips/train traveler/year.

Likely average additional travel after correcting for “overstatement” = 2.06 x 0.25 = 0.51 one-way trips/train traveler/year. The 0.25 factor is an adjustment for “overstatement” of purchase intentions provided by a market resesearch expert with considerable experience in converting purchase intentions to likely purchases (Zackarias 2009). The factor affects the magnitude of the likely additional travel, but our algorithm of which package of improvements is best for a given budget is not affected by the factor.

Likely percent increase in train travel = 0.51/ 3.72 = 13.7%

This assumes that there is sufficient spare capacity.

If only “Cleaner toilets” is implemented, the percent increase will be 6.2% for a “cost” factor of 4. Thus our approach permits managers to consider service improvements in phases by selecting appropriate packages which balance customer preferences and cost.

We plan to present the results to Indian Railways Board so that they can utilize the methodology for enhancing passenger train service.

Summary

Managers need to enhance their service offerings on a fairly regular basis. To do so, they should adopt a robust methodology which balances customer preferences and cost considerations. Our approach recommends that they create a list of possible improvements based on a qualitative survey of current customers. They could then determine the values customers get from the different improvements and also the costs of providing them based on response collected through scientifically administered quantitative surveys of customers and experienced managers. The ASEMAP survey technique estimates customer values for a large number of possible improvements from a customer survey and estimates costs of providing the improvements based on inputs from the service provider. The initial prioritization of improvements can be done through a “bang for the buck” sorting (average value/cost). A more detailed prioritization can be based on the maximum expected increased service usage subject to a cost constraint. If a smaller list of prioritized improvements is selected, it is possible to do a detailed cost analysis, including the initial investment and the subsequent operating costs. The return on the investment can be calculated based in the increased customer life time value based on the expected increased service usage.

In our study, we focused on the core service product, i.e overall travel experience during the train journey. This approach can be extended to cover the remaining elements of the augmented service offering (ASO) (e.g., travel reservation, porter service) as experienced by the customer (Storey and Easingwood, 1998).

References

Berry, L. L., S.K. Lampo. 2000. Teaching an old service new tricks: The promise of service redesign. *J. Service Research* **2** (3) 265-275.

Bolton, R. N., J. H. Drew. 1991. A multistage model of customers' assessments of service quality and value. *J. Customer Res.* **17** 375–384.

Clare, C. C., L. Peter. 2005. A strategic service quality approach using analytic hierarchy process. *Managing Service Quality* **15** (3) 278- 289.

Collier, C. D. 1991. The service quality process map for credit card processing. *Decision Sci.* **22** 406–420.

Cronin Jr., J. J., T. S. Taylor. 1992. Measuring service quality: A reexamination and extension. *J. Marketing* **56**(3) 55–69.

——, S. A. Taylor. 1994. SERVPERF versus SERVQUAL: Reconciling performance–based and perceptions–minus–expectations measurement of service quality. *J. Marketing* **58** 125–131.

Green, P, E., V. Srinivasan. 1990. Conjoint analysis in marketing: New developments with implications for research and practice. *J. Marketing* **54** (4) 3-19.

Kelly, D., C. Storey. 2000. New service development: Initiation strategies. *Internat. J. Services Industry Management*. **11** (1) 45-62.

Musacchio, A., T., Khanna, R., Tahilyani. 2009. Indian Railways: Building a permanent legacy? Case No. 710008, Boston, MA: Harvard Business School Publishing.

Netzer, O., V. Srinivasan. 2011. Adaptive self-explication of multi-attribute preferences, *J. Marketing Research* **48** (1) 140-156.

Ostrom A.L., M. J. Bitner, S. W. Brown, K. A. Burkhard, M. Goul, V. Smith-Daniels, H. Demirkan, E. Rabinovich 2010. Moving forward and making a difference: Research priorities for the science of service, *J. Service Research* **13**(1) 4-36.

Parasuraman, A., A. V. Zeithaml, L. L. Berry 1988. SERVQUAL: A multiple-item scale for measuring perceptions of service quality. *J. Retailing* **64**(1) 12–40.

Pullman, M. E., W.L. Moore 1999. Optimal Service Design: Integrating Marketing and Operations Perspectives. *Internat. J. Service Industry Management* **10**(2) 239-261.

Rust, R.T., A. J. Zahorik, T. L. Keiningham 1995. Return on quality (ROQ): Making service quality financially accountable. *J. Marketing* **58** (2) 58-70.

Sahni, S. 1975. Approximate algorithms for the 0/1 knapsack problem. *J. Association for Computing Machinery* **22** (1) 115-124.

Schneider, B., D. E. Bowen. 1984. New services design development and implementation and the employee. In W. R. George and C. E. Marshal, eds. *Developing New Services*. American Marketing Association, Chicago, IL. 92–101.

——, ——. 1993. The service organization: Human management is crucial. *Organ. Dynam.* **21**(4) 39–52.

Soteriou, A. C., R. B. Chase. 2000. A robust optimization approach for improving service quality. *Manufacturing and Service Operations Management* **2 (**3) 264-286.

Srinivasan V., G. A. Wyner 2009. An improved method for the quantitative assessment of customer priorities", in *Proceedings of the Sawtooth Software Conference,* Sequim, WA: Sawtooth Software, 143-161.

Storey, C., C. J. Easingwood. 1998. The augmented service offering: A conceptualization and study of its impact on new service success. *J. Product Innovation Management* **15** (4) 335–351.

________ ,__________ .1999. Types of new product performance: Evidence from the consumer financial sector. *J. Business Research.* **46** 193–203.

Sudhir, K., S. Mehrotra. 2009, *Bankruptcy to Billions: How the Indian Railways Transformed Itself.* Oxford.

Zacharias, Barry (2009). Private Correspondence.

Table 1 : Improvements Suggested by Respondents

(Frequency of mention in parentheses)

1.	Cleaner toilets (31)
2.	Cleaner coaches (19)
3.	More punctual trains (19)
4.	Better quality and hygiene in food service (15)
5.	Shorter travel time (12)
6.	Greater safety at the stations (11)
7.	Cleaner platforms (10)
8.	More trains/coaches (9)
9.	Greater overhead luggage space (9)
10.	Less unauthorized persons entering reserved coaches (7)
11.	More comfortable seats (7)
12.	More service oriented front line staff (7)
13.	Internet with wi-fi access (6)
14.	Arrival/departure times announced inside coaches (6)
15.	Newspapers and magazines provided (5)
16.	Seating rearranged so that people face each other (5)
17.	Less crowding on the platforms (4)
18.	Audio-video entertainment inside coaches (4)
19.	Less shaking of coaches (3)

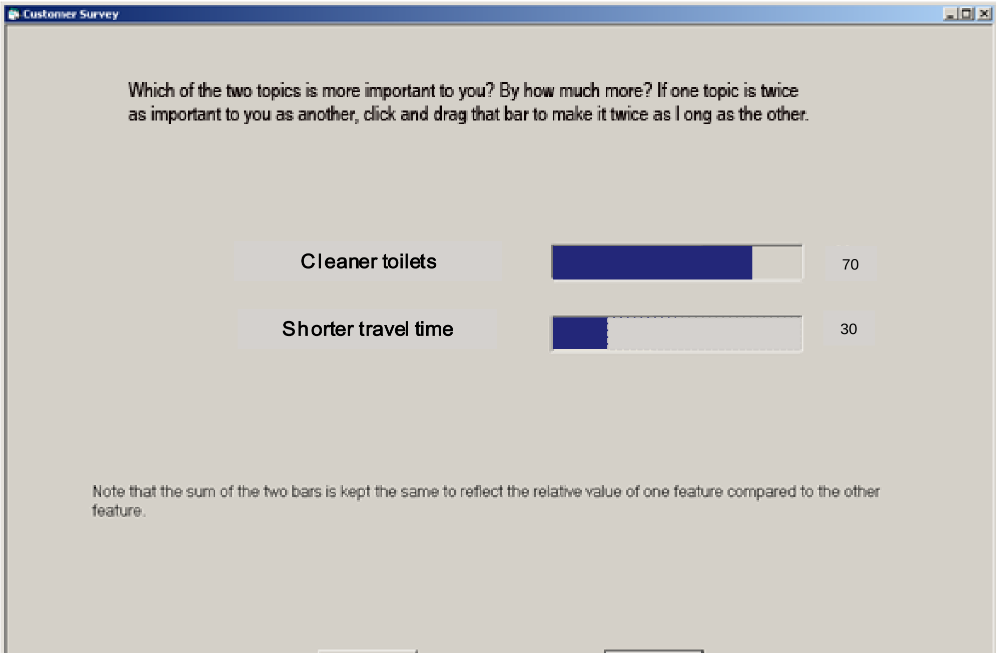
Table 2: Average Values of Improvements (n= 203)

		Mean
1	Cleaner Toilets	10.59
2	Greater safety at the stations	9.59
3	Better food quality & hygiene	7.64
4	Shorter travel time	7.50
5	Cleaner coaches	6.69
6	Less unauthorized persons	5.70
7	More punctual trains	5.48
8	Cleaner platforms	5.43
9	More comfortable seats	5.15
10	More trains/coaches	4.97
11	Better staff service	4.89
12	Internet/wi-fi access	3.97
13	Less shaking of coaches	3.73
14	Announce arrival/departure times	3.51
15	Less crowded platforms	3.50
16	Greater overhead luggage space	3.31
17	Audio-video entertainment	3.23
18	Newspapers and magazines	2.88
19	Seating facing each other	2.24
	Total	**100.00**

Table 3 : Results: “Bang for the Buck”

#	Improvements	Avg. Value	Avg. Cost	Value/ Cost
1	Cleaner toilets	10.60	3.96	2.68
2	Better quality and hygiene in food service	7.64	3.66	2.08
3	Cleaner coaches	6.69	3.52	1.90
4	Newspapers and magazines provided	2.88	1.52	1.89
5	Greater safety at the stations	9.59	6.18	1.55
6	Internet / wi-fi access	3.97	2.68	1.48
7	Cleaner platforms	5.43	3.78	1.44
8	Audio-video entertainment inside coaches	3.23	2.68	1.21
9	Arrival and departure times announced inside coaches	3.51	2.98	1.18
10	Less unauthorized persons entering reserved coaches	5.70	4.98	1.14
11	More comfortable seats	5.15	4.53	1.14
12	More service oriented front line staff	4.89	4.44	1.10
13	Less crowding on the platforms	3.50	4.33	0.81
14	More punctual trains	5.48	7.00	0.78
15	Greater overhead luggage space	3.31	4.45	0.74
16	Seating rearranged so that people face each other	2.24	4.06	0.55
17	Shorter travel time	7.50	14.62	0.51
18	More trains / coaches	4.97	10.69	0.46
19	Less shaking of coaches	3.73	9.96	0.37

Figure 1. Paired Comparison of Attribute Improvements



Which of the two topics is more important to you? By how much more? If one topic is twice as important to you as another, click and drag that bar to make it twice as long as the other.

Cleaner toilets	70
Shorter travel time	30

Note that the sum of the two bars is kept the same to reflect the relative value of one feature compared to the other feature.

Figure 2 – Interpolation of Values for Intermediate Attributes

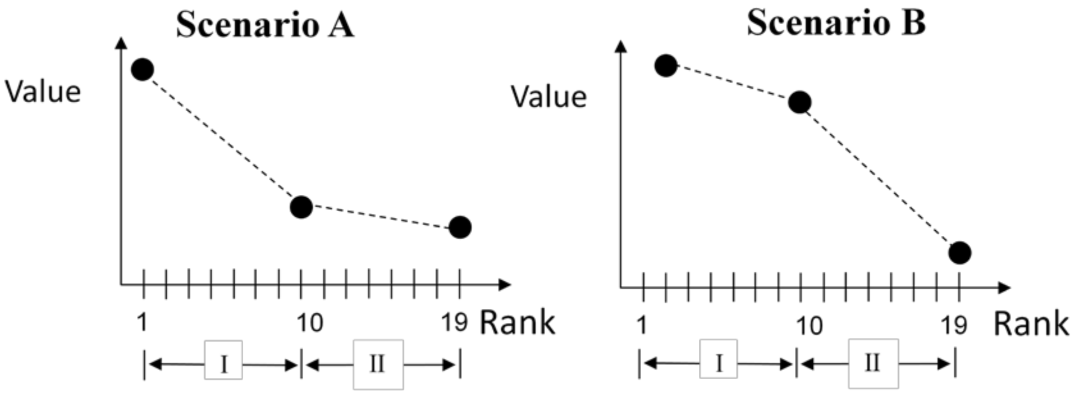


Figure 3. Maximum Possible Interpolation Error

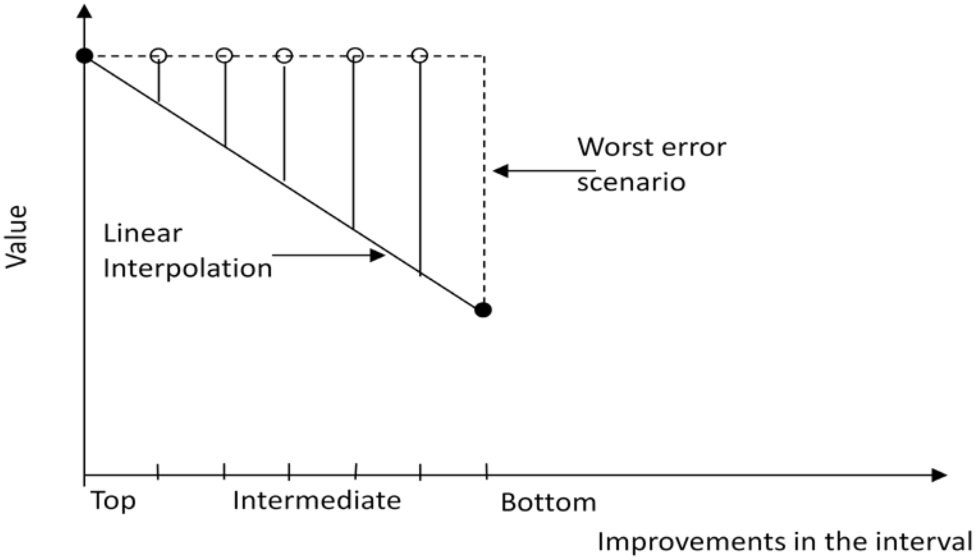


Figure 4. Adaptive Choice of Paired Comparisons of Attributes

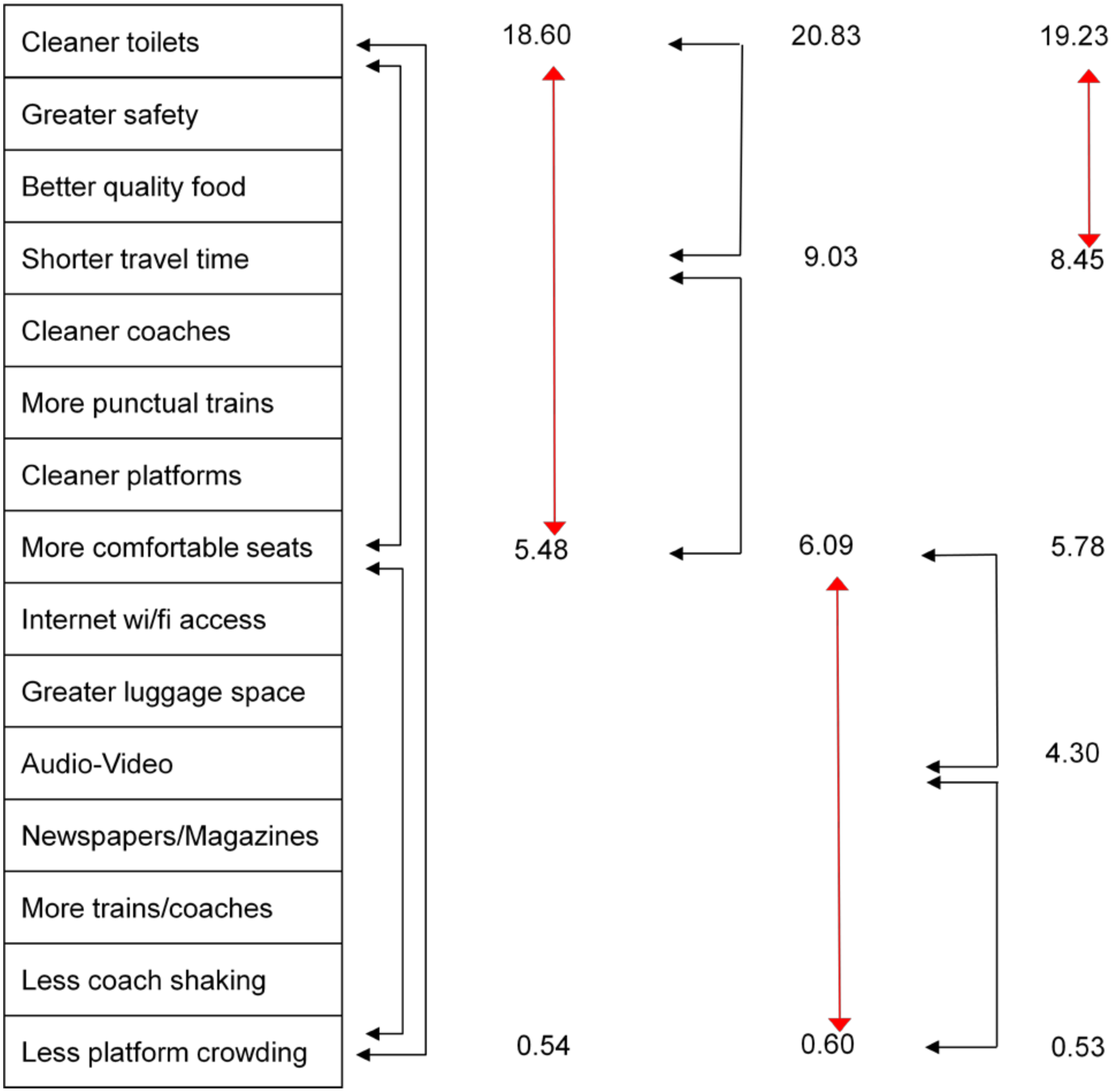


Figure 5. Customer Preferences and Costs

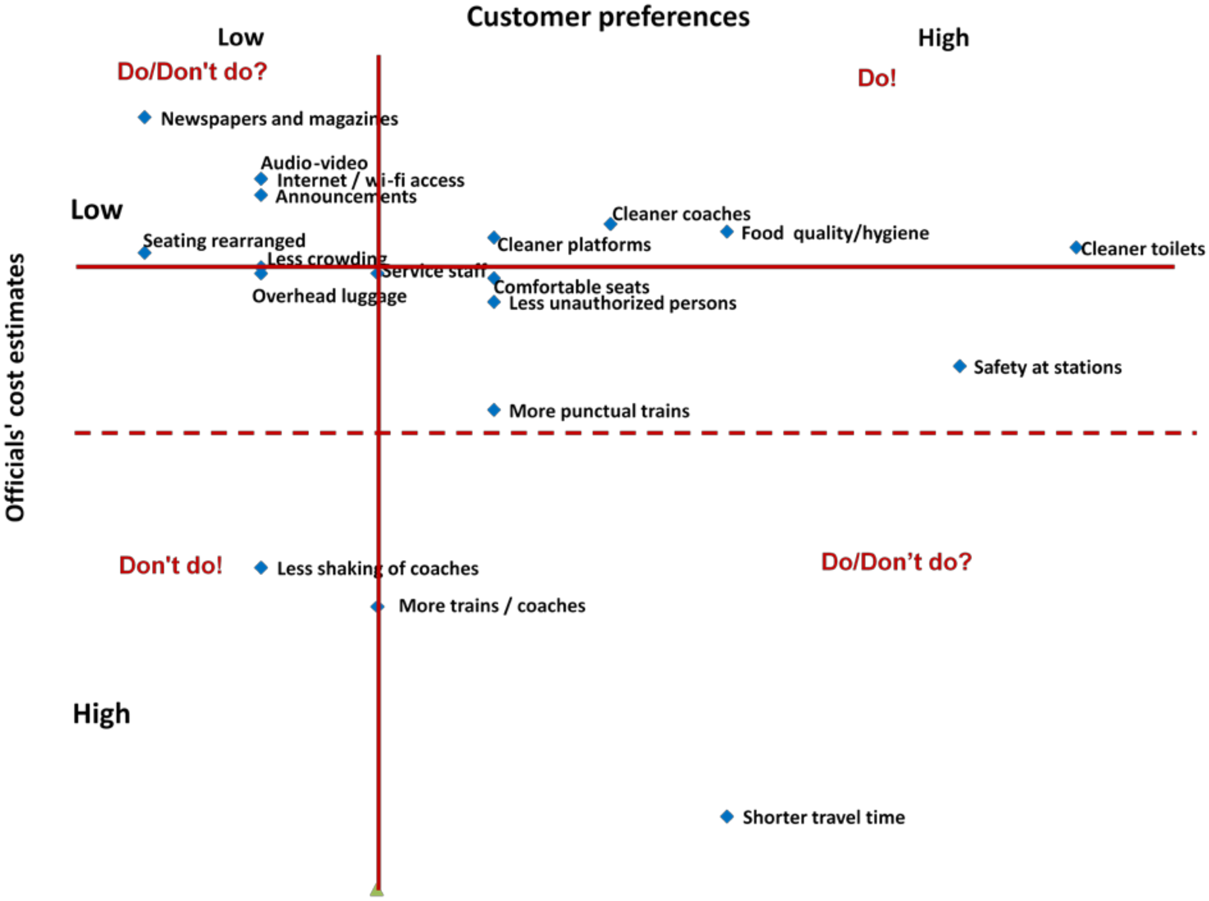


Figure 6. Relationship Between Incremental Value of Improvements and Intended Additional Travel

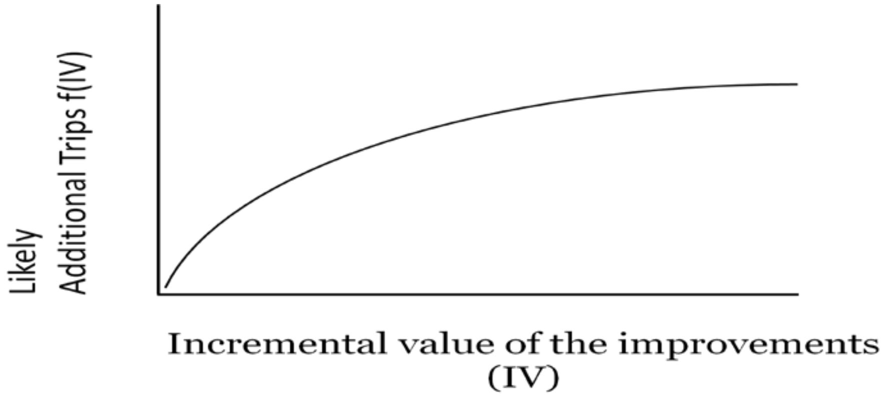


Figure 7. Likely Additional Travel/Customer