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Using the Analytical Hierarchy Process as a Tool for Assessing Service Quality

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Abstract. Continuous quality improvement through process refinement is a must for survival of all industries in the contemporary market place. This is true for both manufacturing and service sectors. While manufacturing has spearheaded quality efforts, the service sector has lagged behind primarily because of inherent difficulties. Customer satisfaction is perhaps the most important performance measure for service quality. There are a number of quality dimensions in service quality, such as reliability, responsiveness, assurance, empathy, and tangibles. An issue of concern is 'how can one have a unified measure of service quality across all the dimensions?' The intent of this paper is to determine if the Analytical Hierarchy Process (AHP) method could be used to derive a single quality index. AHP is a quantitative technique that structures a multi-attribute, multi-person and multi-period problem hierarchically so that solutions are facilitated. This paper presents the development of an AHP model and the derivation of a Quality Index through it. The model is used in a hypothetical case and a quality index was developed. The advantages of using such a technique are discussed.

Keywords: Analytical Hierarchy Process, Service Quality, AHP

1. INTRODUCTION

The last two decades have seen a plethora of changes in the contemporary world. Manufacturing, which used to be a primary driver in any nation's economy, has begun to play a secondary role to services, which now has assumed a major role in every economy. The demarcations between manufacturing and services have begun to evaporate. Needless to say, it is the fast-paced information technology and its causal computer software and hardware that have caused this. One of the main issues is what ramification these have for quality? Or in other words, where is quality in all these?

Historically, manufacturing has been in the forefront in spreading quality. Chronologically one should trace the quality movement in the manufacturing world as shown in Table 1.

Three major developments can be traced from Table 1. First, the use of statistics to access and improve product quality; second, the notion that well rounded quality management systems guarantee product quality; and finally, the notion that ensuring a capable process will guarantee product quality. It should be noted that in all these the final acceptance of the product by consum

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is the ultimate proof of quality, and that some measurable performance metric is needed to drive all the efforts. The notion that the customer acceptance is the final word in quality has driven quality efforts in service industries.

A service is a result that customers want. Services are generally obtained by engaging in an interactive process with the service provider. Quality is a multidimensional phenomenon, meaning different things to different people. One common notion of service quality that is discussed by Garvin (1984) is that services that meet customer preferences and expectations are considered to be of high quality. This definition is quite different from the one typically used in the manufacturing quality literature, which is meeting the established internal standard. According to Parasuraman, Zeithaml and Berry (1985), examination of early literatures on services suggests "three basic underlying themes:

(1) Service quality is more difficult for the consumer to evaluate than goods quality;
(2) Service quality perceptions result from a comparison of consumer expectations with actual service performance and quality evaluation are not made solely on the outcome of a service;
(3) Service quality also involves evaluations of the process of service delivery".

Table 1. Chronology of Quality Efforts in Manufacturing (Axelsson, 1999)

Time Period	*Status of Quality*
Middle of 19th century	Period of no inspection
Late 19th century	Period of 100 per cent inspection
Early 20th century	Formation of first quality department
From 1920s	Start of statistical quality control
From 1940s	Standardization efforts in sampling plans
From 1940s	Recognition of need for quality system
From 1950s	Development of Total Quality Circle concept
From 1970s	Change of focus from product quality to
	Process quality
	Total Quality Management efforts
From 1980s	Use of design of experiment techniques to
	Optimize processes
	Global quality award movements
From 1990s	International standardization of quality
	Management systems efforts (ISO 9000 movement)
Present	Software quality, information interaction quality
	Web design quality, etc.

In a review on similarities and differences in quality efforts between service and manufacturing industries, Gummesson (1992) reports that two common prejudices that exist today: 'Manufacturing people think that service quality can be handled the same way as goods quality', while 'Service people think that service quality is more difficult to assess than goods quality and that goods quality is no problem as everything is tangible and measurable.' While it is true that performance measures in service industries are not as easy to measure as in manufacturing quality, this reason should not prevent quality efforts from being taken. Service quality has been studied and discussed by many researchers since the early 1970's.

The first issue in service quality is identification of the measurement criteria of service quality. This involves identification of quality dimensions, quality elements and quality attributes. Early studies have suggested three basic components, which were called the "three P's" (Haywood-Farmer, 1987): "Physical Facilities, Process and Procedure, People's Behavior, conviviality and Professional Judgment". Parasuraman, Zeithaml and Berry (1985) proposed a conceptual model for service quality based on their exploratory qualitative investigation. They conducted focus group interviews with consumers and in-depth interviews with executives to develop a conceptual model of service quality. From their model, they showed that regardless of the type of service, consumers used basically similar criteria to evaluate service quality. 10 determinants of perceived service quality were developed: "access, communication, competence, courtesy, credibility, reliability, responsiveness, security, tangibles and understanding/knowing" the customers. Haywood-Farmer (1987) proposed a similar conceptual model of service quality, which can apply to various types of service-producing organization. According to him, the special nature of the services results in a number of characteristics: Intangibility, heterogeneity, and customer involvement in service production. By integrating the different types of the service organizations, he proposed a three-dimensional classification-scheme for service quality model with one dimension of degree of contact and interacts, one dimension of degree of labor intensity, and one dimension of degree of service customization. Some other researchers such as Harvey (1998) and Cronin and Taylor (1992) have developed similar service quality models. Harvey (1998) discussed service quality in four related aspects: quality of process and results, perceptions, and expectations. Cronin and Taylor (1992) found that there is a relationship between service quality, consumer satisfaction and purchase intentions. Based on the investigation, the authors proposed a conceptual model of service quality and tested the significance of relationships mentioned above.

The second issue is the measuring and assessing service quality methods. In manufacturing sectors, techniques such as statistical process control, process capability and design of experiment (DOE) are some of the tools that are

mostly used. These procedures are certainly applicable for service industries as well. However, goods quality can be well assessed by pre-defined objective standards, while for service quality, due to the absence of objective measures, an appropriate approach for assessing the quality of service is to measure consumers' perception of quality (Parasuraman, Zeithaml and Berry, 1988). Parasuraman, Zeithaml and Berry (1988) developed a multiple-item scale called SERVQUAL to measure such perception. The basic procedure is the definition and generation of scale items, data collection, and scale purification. By using this scale, service sectors can periodically track service quality trends, assess service quality and determine their relative importance. Cronin and Taylor (1994) identified another similar approach that was called the performance-based measure of service quality (SERVPERF). Based on these researches, many other models have been developed later, such as importance-weighted SERVQUAL (Zeithaml et al. 1990). Harvey (1998) proposed a Quality Functions Development (QFD) approach to improve service quality. The major output of the QFD is a set of service standards and targets for all-important aspects for service and the service delivery process (SDP). These standards can be applied for "setting" for the QFD parameters that maximize customer satisfaction and competitive advantages.

The most successful service organizations compete on the basis of excellent servic**e,** and the payoff of their efforts is competitive differentiation, better customer relationships, and customer word-of-mouth advertising and greater productivity. In a recent American Management Association survey of North American, West European and Japanese managers, 78 percent of the sample indicated that improving quality and service to customers is the key to competitive success (Rosander, 1989). The same study reveals that only 56 per cent of the respondents see service as a clear and accepted priority throughout their organization. In only 49 percent of the companies are regular reports on consumer satisfaction prepared, and only 38 percent of the respondents indicate that most managers in their firms have attended a learning/training activity on customer service.

Many service industries are taking their first small, painful step in quality improvement. Stores, banks, insurers and airlines are deciding that their real stock-in-trade lies in keeping customers happy. At first Hawaiian Bank, tellers with a free moment phone long-time depositors to thank them and ask how service might be improved. In order to reduce performance errors, Allstate Insurance Company is teaching workers to think like experts. Early results are impressive: accuracy has doubled while performance time has halved. As another example, the University of Wisconsin, among public sector, is working with public schools, police department and state agencies to improve their performance (Otis, 1991).

Quality is a multidimensional phenomenon. For example, in manufactured goods, it can be reliability of performance, conformance to standards, features and serviceeability; in service quality it could be functionality, reliability, responsiveness, assurance, empathy and tangibles (Parasuraman et al. 1994; Gummesson, 1992). While objective measurements provide a number of opportunities for combining the different dimensions in a variety of ways in goods quality, in service quality the challenge has always been to determine how to combine the different dimensions. One could argue the futility of such an approach, given that the dimensions are independent. It can be argued that the sheer diversity in service sector may imply varying importance of the quality dimensions for different industries within the service sectors. It can also be argued that for continuous quality improvement, a single comprehensive metric may be better to track quality. So it can be postulated that the different measures of service quality such as "reliability, assurance, responsiveness, empathy and tangibles" could be combined into a single global measure by using Analytical Hierarchy Process (AHP) (Bishu and Rajurkar, 1999).

2. Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP), first developed by Saaty (Winston, 1993), is a quantitative technique that facilitates structuring a complex multi-attribute problem, and provides an objective methodology for deciding among a set of solution strategies for solving that problem. Its application has been reported in numerous fields, such as transportation planning, portfolio selection, corporate planning and marketing (Canada and Sullivan, 1989). It involves a) development of relative importance among the attributes using experts' opinion or through exhaustive paired comparison analysis, b) developing through an algorithm a weightage for each of the attributes, c) performing similar analysis for the alternative solution strategies for each of the attributes, and d) developing a single overall

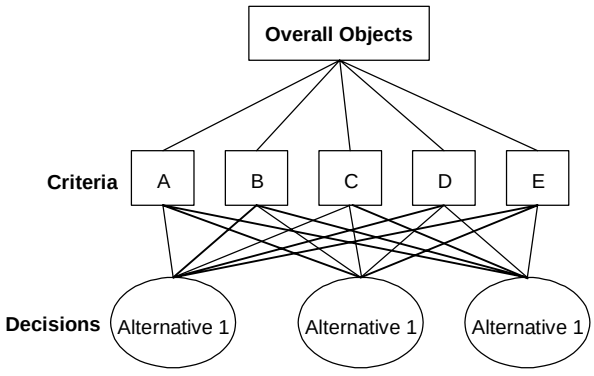

Figure 1. A Hierarchical Structure of AHP

score for each of the alternate solution strategies. The ultimate rationale is that one could rank and order the alternate solution strategies on their final score and choose the best. Figure 1 shows a schematic sketch of the structure.

2.1 An Example of AHP

The AHP includes the following steps:

- Develop a hierarchy structure of the decision problem in terms of overall objective.
- Determine the relative priorities of criteria that express their relative importance in relation to the element at the higher level, on a pair-wise basis;
- Calculate the overall rating of the decision alternatives, weighting the ratings with the relative priorities of criteria and sub-criteria;
- Check the consistency of the decision-maker's comparisons;

Let us consider a hypothetical example of a problem with five attributes (A, B, C, D, and E) and three alternate solutions (S1, S2, and S3). The first step of the AHP consists of developing a hierarchical structure of the assessment problem. The basic assumption of this hierarchical structure is that the attributes are homogeneous in terms of all the determinants. Another issue need to be mentioned here is that, for an effective application of the AHP, it is important that the hierarchical structure includes only criteria that are independent, not redundant and additive. This would ensure a valid comparison and good consistency. For dependent cases, the AHP framework should be modified using the feedback approach and super-matrix approach (Rangone, 1996).

2.2 Determining the relative importance of determinants

The next step would use expert opinions to gather information on the relative importance of these dimension based on a pair-wise comparison. Preference scale is shown in Table 2.

Initially a raw data preference matrix could be arrived at using expert opinion. That matrix could then be normalized using AHP rules (Winston, 1993). Table 3 shows a raw data preference matrix for a hypothetical set of five determinants:

Table 2. Pair-wise Comparison Scale (i to j) for AHP preference

Verbal Judgment	**Numerical Rating***
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1

* 2, 4, 6, 8 are the intermediate value

Table 3. Matrix of Pair-wise Comparison

	A	B	C	D	E
A	1.00	3.00	0.50	6.00	0.20
B	0.33	1.00	0.17	2.00	0.11
C	2.00	6.00	1.00	8.00	0.33
D	0.17	0.50	0.13	1.00	0.11
E	5.00	9.00	3.00	9.00	1.00
Total	8.50	19.50	4.79	26.00	1.75

To normalize this matrix, divide each entry in each column by the sum of the entries in that column, the normalized matrix is shown in Table 4.

The cell entry in Table 4 is obtained by dividing the corresponding cell value by its column total of Table 3. The last column in Table 4, which is the average of the row entries, is the relative weight of the attributes. Saaty (Winston, 1993) has verified that this procedure can give a correct approximation of the exact weights. Also, there are some software packages, such as Expert Choice which can give the exact value.

Table 4. Normalized Matrix of paired Comparisons and Calculation of Priority Weights

	A	B	C	D	E	Row Sum	Weight
A	0.12	0.15	0.10	0.23	0.11	0.72	0.14
B	0.04	0.05	0.03	0.08	0.06	0.27	0.05
C	0.24	0.31	0.021	0.31	0.19	1.25	0.25
D	0.02	0.03	0.03	0.04	0.06	0.17	0.03
E	0.59	0.46	0.63	0.35	0.57	2.59	0.52
Sum	1.00	1.00	1.00	1.00	1.00	5.00	1.00

2.3 Check of Consistency

In order to have a valid comparison, we need to check the consistency of the pair-wise matrix. Saaty (Winston, 1993) also gave a simple four-step procedure to calculate the consistency index (CI). Let A denote the original pair-wise comparison matrix, w denote our estimate of weights, w^T is the transpose of w.

Step 1: Compute Aw^T;

Step 2: Compute $R = \frac{1}{n}\sum_{i=1}^{n} \frac{ith\ entry\ in\ Aw^T}{ith\ entry\ in\ w^T}$;

Step 3: Compute CI as follows: $CI = \frac{R-n}{n-1}$;

Step 4: Compare CI to the random index (RI) from Table 5. Compute $\frac{CI}{RI}$

Table 5. Values of Random Index (RI) (Winston, 1993)

n	RI
2	0
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.51

If CI is sufficiently small, the decision-maker's comparisons are probably consistent enough to give useful estimate of the weights for the objective. Usually, if $CI / RI < 0.1$, the degree of consistency is satisfactory, otherwise, serious inconsistencies may exist. For our example, suppose we have three alternative decisions:

	A	B	C	D	E
Alternative 1	0.2	0.3	0.3	0.1	0.1
Alternative 2	0.5	0.2	0.1	0.1	0.1
Alternative 3	0.2	0.2	0.1	0.2	0.3

Then the total score for these alternatives are:

Alternative1=
0.2(0.14)+0.3(0.05)+0.3(0.25)+0.1(0.03)+0.1(0.52)=0.173

Alternative2=
0.5(0.14)+0.2(0.05)+0.1(0.25)+0.1(0.03)+0.1(0.52)=0.16

Alternative3=
0.2(0.14)+0.2(0.05)+0.1(0.25)+0.2(0.03)+0.3(0.52)=0.225
So alternative 3 is the best decision for our example.

2.4 Case Study

We argue that a modified version of this technique has the potential to be used in the arena of service quality. The rationale for this argument stems from the following. Industries in the service sector vary in diversity ranging from transportation to banking and finance to health care. Other than the fact that both customer and service provider are involved in the production of service, nothing else is common among these industries. Further, customer satisfaction appears to be the only reasonable performance metric for all these. It is also true that the five determinants of service quality (Parasuraman et al. 1994) are valid for all the industries in the service sector. We argue that the relative importance of these determinants may be different for different industries, which is all the more reason that a procedure such as AHP may be the best for determining, monitoring, and tracking quality. As a case study to test this concept, we gathered data from a local bank. The five quality determinants (Parasuraman et. al., 1994) were used. They are:

Table 6 Normalized Value for the Quality Dimensions of a bank service

	Reliability	Responsiveness	Assurance	Empathy	Tangibles	Row Sum	Weight
REL	1.00	2.00	0.50	7	5.0	1.39	0.278
RES	0.50	1.00	0.25	3	2.0	0.64	0.128
ASS	2.00	4.00	1.00	9	8.0	2.43	0.486
EMP	0.14	0.33	0.11	1	0.5	0.21	0.042
TAN	0.20	0.50	0.13	2	1.0	0.33	0.066
Sum	3.84	7.83	1.99	22	16.5	5.00	*1.000*

- *Responsiveness*: The willingness to help consumers and provide prompt service.
- *Assurance*: The knowledge and courtesy of employees and their ability to convey trust and confidence;
- *Reliability*: The ability to perform the promised service dependably and accurately;
- *Empathy:* The caring individualized attention provided to customers;
- *Tangibles*: The appearance of physical facilities, equipment, personnel and communication materials.

Raw data was gathered from the staff of a local bank. Initially expert (with more than five years experiences in bank customer services) opinion was gathered from the management personnel to get the relative importance of the five quality dimensions enumerated above. The data was then normalized as per the procedure enumerated above. Table 6 gives the normalized matrix for the five dimensions.

The value of CI calculated using the procedure above is 0.0083 < 0.1, so the degree of consistency is well satisfied, one could say that the weights are valid. It is clear from Table 6 that assurance and reliability are more important than the other three dimensions, it is consistent with our intuition and common sense, usually concerning a bank service, the reliability and assurance would be the most important issues that customers care about.

Using the weights above would help us simply assess the service quality by obtaining its Quality Index (QI). A survey was designed with three questions in each of the five quality dimensions. A 7-point likert-type scale ranging from –3 to +3 was used to record responses. Twelve participants, all working as a counter clerk in the local bank (all have more than 1 years experiences working with customers), participated in this survey. The average scores for the five dimensions were shown in Table 7.

Table 7. Mean Score for the Five Dimensions

Dimension	*Mean Score*
Reliability	1.33
Responsiveness	2.00
Assurance	1.00
Empathy	0.67
Tangibles	-.67

From the above table, it is also evident that reliability and responsiveness scored higher than the other dimensions. We could define Quality Index (QI) as the weighted sum of all the scores, in this case the score will be:

Quality Index =

$$0.278 \times 1.33 + 0.128 \times 2 + 0.486 \times 1 + 0.042 \times 0.67 + 0.066 \times (-.67)$$

Or Quality Index =1.096

A Quality Index could be derived as shown above. Initially, we could use the index as a descriptive measure and use the same to drive the quality assurance and control efforts. In relative terms, higher this index for an organization, the better is the quality level in that organization. This case study demonstrated the practical procedures for conducting such a comparative study to assess the service quality. One should keep in mind that the results presented here were preliminary, needs to be cross-validated by using customer's rating data. A further AHP study on the customer's rating on the same bank is desired to investigate the correlation between these different groups.

3. Discussion and Conclusion

In summary, quality is very important for service sectors, yet very difficult to assess due to its diversity, complexity and intangible nature. In this article, we propose an AHP approach to determine, monitor and control service quality. Relative weights of quality dimensions were derived from AHP method. The dimensions themselves were assessed through a survey. Combining these two, a Quality Index was derived.

We suggest that service organizations could use a consolidated index such as Quality Index to track their quality level and improve the same. There are a number of reasons that make such an index intuitively appealing. It uses an expert opinion base for generating relative importance among the quality dimensions. While one may argue that all dimensions of quality are equally important, as a matter of fact they are not. Hence getting an index based on different dimensions all weighted in some order of importance would be a better overall measure. It will also provide a better direction for deciding where to devote resources for more effective improvement and better results. Further, one could use survey instruments to measure both expectation and actual performance in the five dimensions of service quality to somehow fill the gaps between them. These values would also help in providing valuable information as to where to improve. Finally, organizations interested in quality improvement could track the Quality Index as well as its components over time to ensure continuous improvement, a necessary requisite for enforcing Total Quality Management efforts. A general procedure for use of this method for any service quality measure would be:

- Identify the relevant quality dimensions
- Develop preference matrix among them using expert opinion
- Develop relative importance weights using AHP
- Design survey instruments for measuring quality dimensions
- Compute quality index after data collections using survey instruments
- Use the quality index as both descriptive and control tools for continuous quality improvement efforts.

It is a fact that a good portion of success of manufacturing industries is due to its commitment to quality. There is adequate reason to believe that service industries, which have started investing in quality recently, will also reach the same heights in quality consciousness as its cousin, the manufacturing world.

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