Expectations and Perceptions in Engineering Consulting Project Management Quality Services: A Gap Analysis Using AHP Method and SERVQUAL Model

Joseph Berlin P. Juanzon

***Abstract*—Measuring client satisfaction is one of the greatest challenge in implementing quality services. Quality affects the performance of the services as well as clients' satisfaction, therefore measuring the gap between clients' expectations and service provider's perception of quality services will help in identifying the real definition of quality services in the service industry. The purpose of this study is to analyze the gap of quality of services in the Engineering Consulting (EC) services using modified SERVQUAL model and AHP method. For engineering consulting service, the interpretation of the clients' needs is very critical. Therefore, having a better understanding of the clients' needs will produce an effective and efficient implementation of the engineering project. In this study project managers of a leading consulting firm in the Philippines were surveyed using pairwise questions on the five generic factors of SERVQUAL model and was compared with the representatives of the leading government agency implementing large infrastructure projects. Using AHP method and geometric mean, gap analysis was performed to identify the priority quality factors between clients' expectations and EC's perceptions of quality services. Results shows that "Reliability" or the ability to performed service dependably and accurately is the top priority in quality services for both EC's and clients. It was only in "Responsiveness" and "Assurance" that the EC's quality perception is higher that the clients' expectations using AHP method and geometric mean gap analysis.**

***Index Terms*—Quality services, AHP, gap analysis, engineering consultant, SERVQUAL.**

I. Introduction

In recent years, the clients have increased reliance on the use of engineering consulting services throughout the world [1]. The technical and contractual intricacy of today's infrastructure and construction projects necessitates the appointment of competent Engineering Consultant (EC) to preserve the rights and interests of the client [2]-[5]. Engineering consultant (EC) are now widely used by private and government agencies to ensure that quality of design will be met for smooth implementation of projects during the construction phase. Engineering consultant (EC) is one of the key players in a construction project as they serve to uphold the interests of their client (and prospective users) throughout the whole project cycle. According to Cooley [4], a competent and reliable EC is crucial to the success of a construction project, as they could bring genuine and everlasting values to the client through innovative, functional, safe, environmental-friendly design, well controlled budget and program, as well as enduring and easy to maintain facility [6].

However, many clients have complained about the service of consulting firms, clients often assert that consultants lack expertise, specialized knowledge or objectivity, and fail to produce client's overall expectations in delivering quality project management services [7].

Since the consultancy services could cover a series of stages within the entire project life cycle, it is necessary to identify the stage(s) in which an EC would have the greatest input. As pointed out by Pilcher [8], 80% of construction costs are taken when the sketch design is formulated, and any design errors and omissions if undetected or unresolved could inevitably lead to serious claims and reworks once the construction begins. Burati *et al.* [9] advocated that the cost of any design errors would exceed that attributable to those generated by construction (i.e. 9.5% as opposed to 2.5% of the total project cost). This highlights the importance of the design stage, and hence the performance of the ECs at the design stage should be carefully scrutinized.

Quality services of EC's in preparing design solutions should satisfy all requirements relating to the technical, financial, environmental, safety and quality standards as set out in the client's terms of reference, and this can be measured as a percentage of the design solutions that fulfils the technical, financial, environmental, safety, and quality standards of the project.

The aim of this study is to identify the gap in delivering quality services between clients' expectations and EC's perception in delivering engineering design services using SERVQUAL model and AHP method.

A. SERVQUAL in the EC's Services

Understanding exactly what customers expect is the most crucial step in defining and delivering high-quality service [10]. Service quality can be defined as the difference between customer expectations of service and perceived service. The purpose of this study is to measure the gap between the client's expectation and EC's perception of quality project management services. If expectations are greater than performance, then perceived quality is less than satisfactory and hence customer dissatisfaction occurs [11], [12]. Always there exists an important question: why should service quality be measured? Measurement allows for comparison before and after changes, for the location of quality related problems and for the establishment of clear standards for service delivery. Edvardsen [13], state that, in their experience, the starting

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point in developing quality in services is analysis and measurement. SERVQUAL, as the most often used approach for measuring service quality, has been widely used to compare customers' expectations before a service encounter and their perceptions of the actual service delivered [14]. The SERVQUAL instrument has been the predominant method used to measure consumers' perceptions of service quality. It has five generic dimensions or factors and are stated as follows:

(1) Tangibles - Physical facilities, equipment, and appearance of personnel.

(2) Reliability - Ability to perform the promised service dependably and accurately.

(3) Responsiveness - Willingness to help customers and provide prompt service.

(4) Assurance - (including competence, courtesy, credibility, and security)- Knowledge and courtesy of employees and their ability to inspire trust and confidence.

(5) Empathy (including access, communication, understanding the customer) - Caring and individualized attention that the firm provides to its customers.

The SERVQUAL instrument is based on the 5 Gaps, as shown in Fig. 1.0. These gaps on the service provider's side, which can impede delivery of services that consumers perceive to be of high quality.

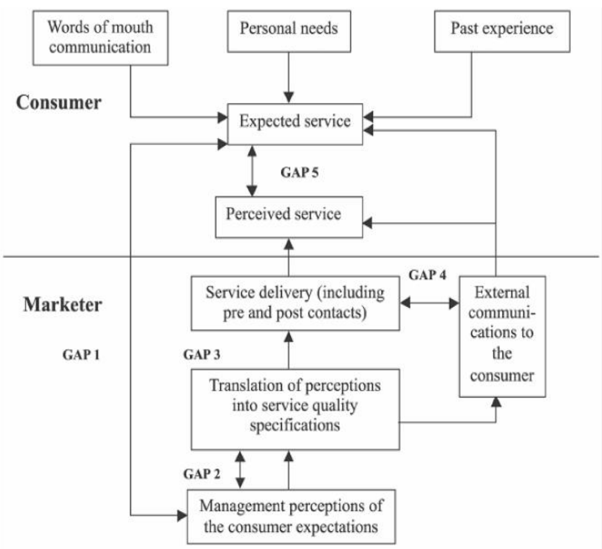

Fig. 1. Model of service quality gaps source: Parasuraman (1985).

- Gap 1 – difference between consumer expectations and management perceptions of consumer expectations.
- Gap 2 – difference between management perceptions of consumer expectations and service quality specifications.
- Gap 3 – discrepancy between service quality specifications and the service delivered.
- Gap 4 –discrepancy between service delivery and what is communicated about the service to consumers.
- Gap 5 (service quality) Gap 5 = f (Gap 1, Gap 2, Gap 3, Gap 4) – difference between consumer expectations and perceptions. I.e. the quality that the consumer perceives in services is a function of the magnitude and direction of the gap between expected service and perceived service. This occurs when the expectation is not exceeded [14].

For this study, Gap model (1) to compare the EC's perception and client's expectation in delivering quality service to implement engineering projects was analyzed.

II. Methodology

A. Analytical Hierarchy Process (AHP)

In this paper, AHP method was used to evaluate service quality in the Engineering Consulting industry. Originally proposed by Thomas L. Saaty in the early 1970s, the AHP has become a popular decision structuring and analysis tool. AHP allows a set of complex issues, which have an impact on the solution to the problem. It breaks down the decision problem to a system of hierarchical structure and derives priorities for the elements in each level of hierarchy according to their impact on the elements (e.g., criteria or objectives) of the next higher level [11], [12]. AHP is a multiple criteria decision-making tool, and is an Eigen value approach to the pair-wise comparisons. It also provides a methodology to calibrate the numeric scale for the measurement of quantitative as well as qualitative performances [15], [16]. The scale ranges from 1/9 for 'least valued than', to 1 for 'equal', and 2 to 9 for 'absolutely more important than' covering the entire spectrum of the comparison. Figure 2.0 shows an example of the pairwise comparison between A and B, and Table 1.0 shows the explanation and interpretation of each scale.

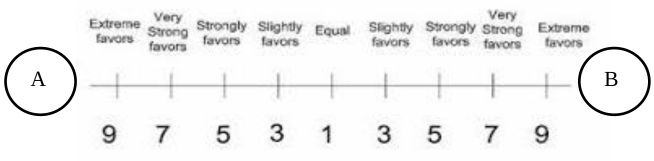

Fig. 2. Pairwise comparison scale.

To decide in an organized way to generate priorities we need to decompose the decision into the following steps [17].

1. Define the problem and determine its goal.
2. Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which sub-sequent levels depend) to the lowest level which usually contains the list of alternatives.
3. Construct a set of pair-wise comparison matrices (size n x n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table I. The pair-wise comparisons are done in terms of which element dominates the other.
4. There are n*(n-1)/2 judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5. Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.
6. Having made all the pair-wise comparisons, the

consistency is determined by using the eigenvalue, λ max, to calculate the consistency index, CI as follows: CI = (λmax x n)*(n- 1), where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table II. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.

7. Steps 3 to 6 are performed for all levels in the hierarchy.

TABLE I: INTERPRETATION OF SCALE

	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak	Between Equal and Moderate
3	Moderate Importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	Between Moderate and strong
5	Strong Importance	Experience and judgment slightly favor one activity over another
6	Strong plus	Between strong and very strong
7	Very strong	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	Between very strong and extreme
9	Extreme Importance	The evidence favoring one activity over another is one of the highest possible order of affirmation

TABLE II: AVERAGE RANDOM CONSISTENCY (RI)

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

B. Questionnaire Design

The SERVQUAL five generic dimensions or factors were used as criterion in evaluating the clients' expected and EC's perceived quality service in engineering project management. The questionnaire is composed of 15 pairwise questions using the equation n(n-1)/2, were n is equal to the number of criteria.

C. Sampling and Survey Procedure

The sample was taken from the professional project managers of an Engineering Consulting firm in the Philippines, who are handling various engineering design projects representing the EC's quality perception, and selected engineering experts from the Department of Public Works and Highways the leading government agencies involved in soliciting engineering design projects, representing the client's quality service expectations.

D. Group Decision Making

Two important issues in group decision making are: how to aggregate individual judgments in a group into a single representative judgment for the entire group and how to construct a group choice from individual choices. The reciprocal property plays an important role in combining the judgments of several individuals to obtain a single judgment for the group. Judgments must be combined so that the reciprocal of the synthesized judgments is equal to the syntheses of the reciprocals of these judgments.

It has been proved that the geometric mean, not the frequently used arithmetic mean, is the only way to do that. If the individuals are experts, they may not wish to combine their judgments but only their final outcomes obtained by each from their own hierarchy. In that case one takes the geometric mean of the final outcomes. If the individuals have different priorities of importance, their judgments (final outcomes) are raised to the power of their priorities and then the geometric mean is formed [14].

E. Calculating the Gap between Perceptions and Expectation

To calculate the gap between clients' expectations and EC's perception of quality service based on SERVQUAL five generic dimensions, the difference of the geometric means for each dimension will be calculated. If the perception is higher than the clients' expectation, then the quality is met on that specific quality dimensions.

F. T-Test Analysis

To test the level of significance, the t-test was performed on each Quality Factors to assess whether the means of two groups are statistically different from each other, using Eq. 1.

$$t = \frac{\bar{x}_t - \bar{x}_c}{\sqrt{\frac{var_T}{n_T} + \frac{var_C}{n_C}}} \tag{1}$$

To test the significance, the alpha level was set at .05 or 95% confidence level to determine the degrees of freedom (df) for the test. In the t-test, it is the sum of the persons/respondents in both groups minus 2. Given the alpha level, the df, and the t-value, the p-value can be looked-up in a standard table of significance to determine whether the p-value is large enough to be significant

III. RESULTS AND DISCUSSIONS

The AHP was used to identify the priority quality factors of both clients' expectations against EC's perceived quality services, and the gap between each factor. Table III shows the summary of the consistency index and consistency ratio for each client. Results of the consistency ratio shows that only clients 3 and 4 has a consistency ratio of less than 0.10, which makes those clients consistent. However, responses of other clients can still be considered as valid data.

TABLE III: CLIENTS CONSISTENCY INDEX AND RATIO

CLIENTS	CI	RI	CR
CLIENT-1	0.579	1.110	0.522
CLIENT-2	0.257	1.110	0.231
CLIENT-3	0.082	1.110	0.074
CLIENT-4	0.265	1.110	0.239
CLIENT-5	0.124	1.110	0.112
CLIENT-6	0.056	1.110	0.050

Table IV and Table V shows the summary of Eigen values of each clients with respect to the quality and the geometric mean and ranking of each factors client's expectations. Based on the client's expectations of quality service "Reliability" or the ability to perform the promised service dependably and accurately is the most priority factor, followed by "Assurance" or the knowledge and courtesy of ECs and their ability to inspire trust and confidence is priority number 2. The least priority is "Tangibles" which includes physical facilities and office layout, equipment, and appearance of personnel.

TABLE IV: CLIENTS EIGEN VALUES

FACTORS	1	2	3	4	5	6
TAN	0.193	0.027	0.025	0.079	0.113	0.101
REL	0.337	0.456	0.405	0.367	0.299	0.212
RES	0.157	0.214	0.189	0.221	0.175	0.169
ASS	0.156	0.142	0.189	0.166	0.237	0.303
EMP	0.156	0.162	0.189	0.166	0.175	0.212

TABLE V: GEOMETRIC MEAN CLIENTS EIGEN VALUES

Factors	Geometric Mean	Ranking
TAN	0.070298	5
REL	0.336646	1
RES	0.186395	3
ASS	0.191939	2
EMP	0.176098	4

With regards to the perceived quality of Engineering Consultants, Table VI the Eigen values of each project managers and Table VII shows that the top priorities for quality services among the project managers is also "Reliability" and "Assurance" which is consistent with the clients' expectations of quality services.

TABLE VI: EC'S EIGEN VALUES

FACTORS	1	2	3	4	5	6
TAN	0.193	0.027	0.025	0.079	0.113	0.101
REL	0.337	0.456	0.405	0.367	0.299	0.212
RES	0.157	0.214	0.189	0.221	0.175	0.169
ASS	0.156	0.142	0.189	0.166	0.237	0.303
EMP	0.156	0.162	0.189	0.166	0.175	0.212

TABLE VII: EC'S CONSISTENCY INDEX AND RATIO

Factors	Geometric Mean	Ranking
TAN	0.031865	5
REL	0.267937	1
RES	0.248629	3
ASS	0.265062	2
EMP	0.116484	4

Considering gap analysis between clients' expectations and EC's perception, Table VIII shows that in the gap analysis, it can be noticed that the clients' expectation on "Tangibles", "Reliability" and "Empathy" is higher than the geometric mean value of the EC's perception, therefore, quality service for those specific quality factors were not met. However, it can also be seen on the table that the "Assurance" and "Responsiveness" quality factors were met, since the geometric mean of the EC's quality perception were higher than the client's expectations. This is a positive indicator that the EC's project managers can easily assured their clients trust and confidence in implementing quality services for their projects.

TABLE VIII: CLIENTS EIGEN VALUES

QUALITY FACTORS	CLIENT EXPECTIONS	EC's PERCEPTION	GAP
TANGIBLES	0.070297885	0.03186507	0.038432815
RELIABILITY	0.336646337	0.267936991	0.068709346
RESPONSIVENESS	0.186395452	0.248629491	-0.062234039
ASSURANCE	0.191939356	0.265061679	-0.073122323
EMPHATY	0.176097665	0.116484487	0.059613179

The t-test result shows that only in tangible quality service factors that the two groups are statistically significant, with a p-value of less than 0.05. Reliability, responsiveness and assurance factors are not statistically significant between the client and EC, as shown in Table IX.

TABLE IX: LEVEL OF SIGNIFICANCE IN QUALITY SERVICE FACTORS BETWEEN CLIENTS AND EC

FACTORS	T-TEST	P-VALUE	REMARKS
TANGIBLE	2.24481	0.0489	Statistically Significant
RELIABILITY	1.33815	0.2105	Not Statistically Significant
RESPONSIVENESS	-1.98041	0.0758	Not Quite Statistically Significant
ASSURANCE	-1.28359	0.2282	Not Statistically Significant
EMPHATY	1.54034	0.1545	Not Statistically Significant

IV. CONCLUSION

The highly competitive market conditions in the Engineering Consulting industry put pressures on Project Mangers to deliver high-quality services in implementing design and construction projects. To provide this, EC firms must first understand customers' needs and expectations. Next, they should focus on how to deliver the most convenient service to meet customers' needs. This study develops a new structure to define EC service quality dimensions.

SERVQUAL points were evaluated by newly calculated weighted scores. The priority weights, were determined through AHP analysis, converting the ordinal scale responses into interval scale. This transformation enabled it to compute and interpret geometric means in a more statistically appropriate manner. "Reliability" was shown to be the most important factor in implementing quality service for both clients and ECs. For EC firms, their ability to perform the promised services dependably and accurately will be the biggest factor in retaining their clients.

On the basis of service quality gaps, it was discovered that "Assurance" has the biggest quality gap based on geometric mean, with EC's perception is higher than the clients' expectations. This finding confirms that, as engineering consultant, knowledge and courtesy of Project Managers was the biggest asset in customer satisfaction. Taking this into consideration, future research should investigate why EC's perceptions were lower than expectations among clients in "Tangibles" and "Empathy", and how this situation can be improved.

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