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# APPLICATION OF DATA ENVELOPMENT ANALYSIS FOR MEASURING SERVICE QUALITY FROM DISTRIBUTORS' PERSPECTIVE IN SUPPLY CHAIN

**Le Thi Phuong Thanh*, Tong Viet Bao Hoang, Hoang Viet Hanh Nguyen**

University of Economics, Hue University, 99 Ho Dac Di St., Hue, Vietnam

**Abstract**: Vietnam's textile and apparel sector has achieved fast and sustainable growth over the past years and played an important role in national socio-economic development. The export value of textile and garment products in recent years has ranked number two in the country's total export revenue. In this scenario, an attempt was made to examine the service quality at the manufacturer – distributor interface of the textile supply chain and provide clear guidelines for benchmarking of service quality in multi-unit services. A sample of 144 distributors from Small and Medium Enterprises (SMEs) in major regions of South Vietnam was selected. Exploratory Factor Analysis was used to identify the critical factors of service quality. This research applies the data envelopment analysis (DEA) approach to the computation of a measure of overall service quality and benchmarking when measuring service quality with the Service Performance model. Dealing with the five dimensions of Service Performance (SERVPERF) as outputs, the proposed approach uses DEA as a tool for multiple criteria decision making (MCDM), in particular, the pure output DEA model without inputs. Data envelopment analysis measures the relative efficiency of decision-making units (DMUs) and identifies a set of corresponding efficient DMUs that can be used as benchmarks for the improvement of inefficient DMUs. The findings shed valuable insights on measures and critical underlying dimensions of service quality in the context of the supply chain in the textile industry, specifically from the distributor perspective. The results also give the best performer in textile SMEs and set the benchmarking guideline within each group among SEMs

**Keywords**: service quality, data envelopment analysis, SERVPERF

## 1 Introduction

Service quality has been considered as a major success factor in the era of intense competition. Several studies have dedicated attention to service quality [1]. Mentzer et al. [31] believed that the relationship between service quality and supply chain performance is wide according to the satisfaction of each member in the supply chain.

The rationale of this paper is to continue the extension of service quality scale development studies to the industrial supply chain context because this research develops a service quality measurement scale for the manufacturers-distributors interface of industrial supply chains.

* *Corresponding:* phuongthanh1503@gmail.com
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This paper approaches the supply chain from the distributors' perspective and seeks to address the following research objectives. Firstly, to determine distributor-perceived service quality in Vietnam's textile industry. Secondly, to examine the contribution made by each dimension of service quality in predicting distributor's efficiency. Finally, to identify the best performers and set benchmarking goals.

The analysis is from the perspective of the distributors. In this paper, the distributors-focal organization dyad involves service quality. The central finding of this paper is that service quality-driven initiatives in the supply chain lead to competitive advantages and enhance the level of performance for an organization. The single measure can also be obtained in various ways, such as a simple sum or average, a weighted sum, or a weighted average, with the weights assigned to each dimension or item. One of the main reasons for producing a single measure of overall service quality across dimensions is to enable benchmarking through comparison. The Service Performance (SERVPERF) model establishes best practices by comparing overall quality scores of service units and then to improve the performance of units that are falling behind [27]. However, a shortcoming arises when using the benchmarking based on a simple aggregated measure because there is little guidance to whom to benchmark and to what degree service quality should be improved. To address this limitation, this paper applies the data envelopment analysis (DEA) approach to compute a single measure of overall service quality and benchmarking in measuring service quality with the five dimensions of SERVPERF.

The remainder of the paper is structured as follows: the next section presents a review of the literature, followed by the conceptual model, research methodology, and the discussion of the results. The paper concludes with the contribution of the work, limitations, and scope for future work.

## 2 Theoretical background

### 2.1 Concept of service quality

Service quality has been differently conceptualized and operationalized. Service quality is described as a multidimensional concept [24, 32, 33]. Firstly, service quality is divided into three dimensions, namely, the "what", the "how" and the image attributed by potential and current customers [24]. Secondly, through measuring the expectations and perceptions of the service, the result is the outcome of service quality [24, 32–34]. Finally, Zeithaml [44] indicated that service quality includes the evaluation of the overall service and measuring three dimensions (process quality, service environment, and technical quality [36]) and represents the sum of a customer's perception of a service [25].

### 2.2 Conceptualization of service quality in the supply chain

In service literature, numerous service quality dimensions are found, and they bear some relevance to the supply chain content. Seth et al. [37] identified 36 dimensions that have their applicability at various dyads of the supply chain. At these dyads, service quality involves forward and reverse flows of service, and the evaluation of which is assessed by calculating the gap between perception and expectation of each service [38].

### 2.3 Measuring service quality and service quality in supply chains

**SERVQUAL and SERVPERF model**

Parasuraman et al. [32] propounded ten dimensions of service quality in the gap model. Service quality is the difference between perceptions and expectations of service. In 1988, a scale was developed with 10 to 22 items for measuring service quality, called SERVQUAL, by Parasuraman et al. [33]. Service quality judgments comprise five underlying attributes: tangibles, reliability, responsiveness, assurance, and empathy. The SERVQUAL comprises 44 items: 22 for expectations and 22 for perceptions. The expectations and perceptions of customers' responses are obtained on a 7-point or 5-point Likert scale and compared to arrive at the perception minus expectation ($P - E$) gap scores. The level of service quality is reflected through the perception minus expectation score (The higher the score, the better the quality of service.)

The development of the SERVQUAL instrument is evident from the amount of related research both on its practical applications and theoretical discussions. Its applications have been reported in a number of practical studies through varied settings. Although the SERVQUAL scale is commonly applied, it has also been criticized on various theoretical and operational grounds [26].

The major issue is the use of the gap score ($P - E$) [11]. This issue has been named operationalization by numerous researchers. Contrary to the original work by Parasuraman et al. [33], the convergent validity of SERVQUAL has often not been confirmed in subsequent studies. Various studies have found that service quality measured with SERVQUAL is not significantly related to that measured directly through the single-item scale [5].

Cronin and Taylor [20] were amongst the researchers who leveled maximum against the SERVQUAL scale. They found the SERVQUAL scale confusing with the service perception based on it. Therefore, they assumed that the expected component ($E$) of SERVQUAL should be removed and, instead, used only the perceived performance component ($P$). They proposed what is referred to as the 'SERVPERF' scale, which directly measures customers' perceived performance. SERVPERF supposes that a higher perceived score infers higher service quality; that is, $Q = P$. In addition to theoretical arguments, Cronin and Taylor [20] furnished empirical evidence across four industries (banks, pest control, dry cleaning, and fast food) to confirm the

superiority of their 'performance-only' instrument over the disconfirmation-based SERVQUAL scale. Evidently, the SERVPERF scale also reduces considerably the number of items in 5 dimensions of SERVQUAL. The theoretical superiority of the SERVPERF scale over the SERVQUAL scale was also shown by Cronin and Taylor [20]. Much vigorous argument has been taking place on whether SERVQUAL or SERVPERF should be used for measuring service quality from the advent of SERVPERF. Most researchers attempted the comparison of the two scales on such various criteria as reliability, content validity, predictive validity, convergent validity, and diagnostic power [5, 10, 26, 27, 45]. However, a controversial issue still exists, and there is not a common agreement on which is better. Numerous researchers have reported that SERVEPRF is a better alternative than SERVQUAL in terms of validity and explanatory power [5, 10, 27, 45]. In 2007, Carrillat et al. [13] showed that both scales are similar valid measures of service quality. However, researchers have reached the nearly general agreement that SERVQUAL is superior to SERVPERF [5, 10, 27]. Because of each of its advantages, Jain and Gupta [26] suggested that one should employ SERVPERF for assessing overall service quality and making comparisons across units, firms, and industries thanks to its higher validity and explanatory power.

This study only aims to show that the proposed DEA approach can be applied to produce an aggregated single measure of overall service quality and benchmarking. Since benchmarking is relevant to the comparison of the overall service quality of multiple local firms, so this study adopts SERVPERF.

**Data envelopment analysis**

Data envelopment analysis is the technique used to compare the performances of several units. These units in the context of services can be various service organizations like banks, hospitals, and schools. This technique is used in places where a relative performance of different units is to be compared and evaluated. Data envelopment analysis can be used to analyze the performance of several units to set a benchmark. The analysis can be used to discover inefficient operations or units, even for the most profitable organizations. Data envelopment analysis has an advantage over other analysis techniques as it can handle complex relations between multiple inputs and multiple outputs, and the units are non-commeasurable. Data envelopment analysis techniques are based on linear algebra and are related to linear programming concepts. The technique is similar to mathematical duality relations in linear programming.

The CCR model is the first DEA model, proposed by Charnes, Cooper, and Rhodes [14], who suppose that production exhibits constant returns to scale. In 1984, the CCR model was extended into the BCC model for cases of variable returns to scale by Banker, Charnes, and Cooper [6]. Data envelopment analysis models are also distinguished according to the objectives: maximize outputs (output-oriented) or minimize inputs (input-oriented). The output-oriented BCC model employed in this study is formulated as where $X$ is the matrix of input vectors; $Y$ is

the matrix of output vectors; ($x_0$, $y_0$) is the decision-making unit (DMU) being measured; $g$ is the reverse of the efficiency score, and $k$ is the vector of intensity variables. The convexity condition is the only difference between the CCR and BCC models.

In addition to the efficiency of the multiple units performing a transformation process of several inputs and several outputs, DEA is also considered as a tool for multiple criteria decision-making (MCDM) problems [9]. Although the traditional goals of DEA and MCDM differ in that MCDM aims to prioritize a set of alternatives with conflicting criteria, most researchers have found similarities between DEA and MCDM [35]. Scholars have recognized that the MCDM and DEA formulations coincide if inputs and outputs are viewed as criteria, with the minimization of inputs and the maximization of outputs [8, 40]. Such criteria can be divided into two types: costs or negative evaluation items (the smaller the value, the better) as inputs and benefits or positive items (the greater the value, the better) as outputs [40]. The efficiency scores of DMUs are considered as priority weights or performance scores in MCDM. When this is the case, it is not assumed that inputs are necessarily and directly transformed into outputs [17]. In some MCDM problems, there is not a negative (or positive) evaluation item. In other words, all criteria are preferred to be high (or low); thus, only outputs (or inputs) will exist when using DEA. To address this problem, Lovell and Pastor [31] suggest the pure output (or input) model without inputs (or outputs). They proved that an output-oriented CCR model with a single constant input and an input-oriented CCR model with a single constant output coincide with the corresponding BCC models, but a CCR model without inputs (or outputs) is meaningless. The pure output model has successfully been employed in various problems, such as target setting for bank services [29], facility layout [43], identification of new business areas, and service-process benchmarking. Since all of the five dimensions of SERVPERF are positive items, this study also adopts the pure output model to aggregate their scores into a single measure of service quality.

## 3 Research methodology

### 3.1 DEA–SERVPERF approach to benchmarking of service quality

Benchmarking of service quality across multiple local firms is one of the practical uses of SERVPERF. Spendolini [39] mentioned that benchmarking can be described as "a continuous, systematic process for evaluating the products, services, and work processes of organizations that are recognized as representing best practices for organizational improvement".

Since only adopting SERVPERF cannot support any of the three steps of benchmarking: 1) identifying the best performers; (2) setting benchmarking goals; (3) implementation [22, 39].

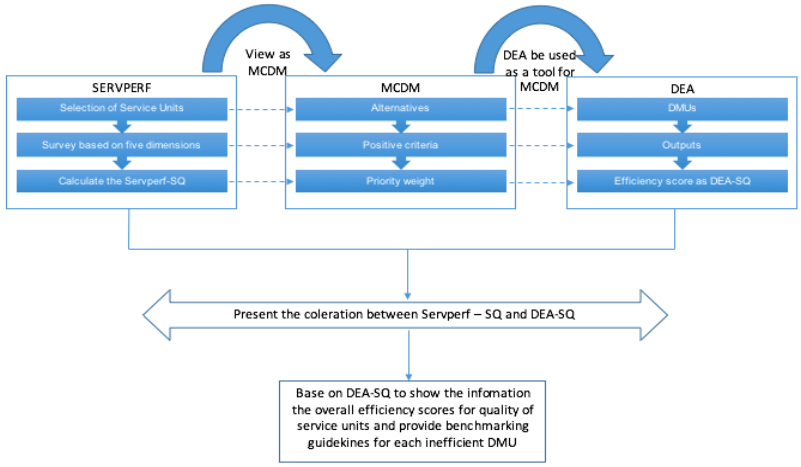


**Figure 1.** SERVPERF–DEA correspondence

The correspondence between SERVPERF and DEA was documented by Lee and Kim [28]. The findings of the DEA not only contain information about the overall efficiency ratings for service units but also provide benchmarking guidance for each inefficient DMU. They suggested a process to benchmark the service quality. Therefore in this study, the DEA-SERVPERF approach is adopted to measure and benchmark service quality in the supply chain of the textile industry.

First, SERVPERF was used to measure the quality of service and provide little guidance in benchmark collection. The unit with the highest score is likely to be considered the best practice, but because of the different management background and culture in each unit, it does not establish persuasiveness for all other units to follow the best practice.

A more reasonable approach was used to assign various related metrics to different units, taking into account their organizational and functional similarities. DEA will solve this problem by allocating a different set of productive units as role models with identical input and output structures for each inefficient DMU.

The SERVPERF measures the overall quality of service units, which can be viewed as an MCDM problem (Figure 1). Five dimensions in SERVPERF are the five criteria that are used to measure the performance of each unit of service quality.

The input/output variables of DMUs are the negative/positive criteria that can be applied as a tool for MCDM for the evaluation of alternatives. Therefore, DEA is capable to aggregate the five dimensions of SERVPERF into a single measure of overall service quality.

Because the five dimensions of SERVPERF are positive items from the perspective of MCDM, this study applies the pure output model of DEA. The pure output-oriented BCC model

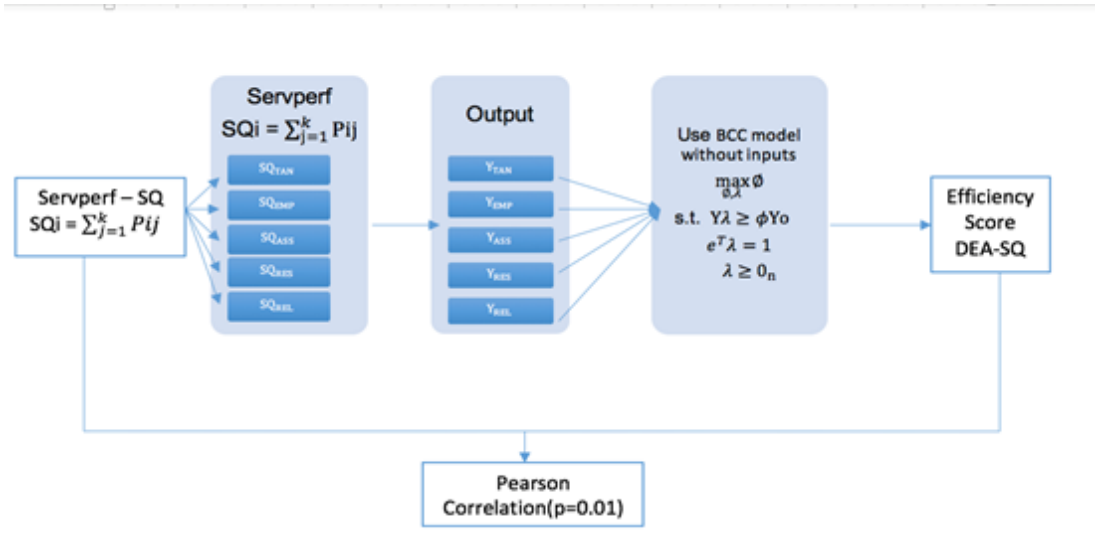


**Figure 2.** SERVPERF–DEA correspondence formulation

is obtained by removing the first constraint corresponding to inputs from the basic form (Figure 2).

### 3.2 Survey design

The questionnaire was based on 22 items of the 5 dimensions of SERVPERF and comprised elements in the service supply chain. Data were collected from 144 distributors of SMEs (Small and Medium Enterprise) in the textile companies situated in South Vietnam. The summary of the data source is presented in Table 1. To reach the respondents who have rich information and are willing to participate in the survey, a snowball sampling approach was followed. 180 companies were approached by email, and data were elicited from 144 respondents, thereby achieving a response rate of 80 percent. SPSS 21.0 was used for data analysis.

In Vietnam, the Small and Medium Enterprises in the textile industry can be grouped into three types:

- A joint-stock company (JSC) is a company in which the charter capital is divided into equal parts called shares that are established and exist independently. A shareholding

**Table 1.** Number of interviewed enterprises by type

| Name of SMEs | Numbers |
|---|---|
| JSC (Joint Stock Company) | 58 |
| LLC (Limited Liability Company) | 40 |
| PC (Private Company) | 46 |

company must have a general meeting of shareholders, a board of management, and a director (general director). In the case of a shareholding company with more than eleven shareholders, there must be a board of controllers. Shareholding companies have the right to issue securities under the law on securities.

- Limited liability companies (LLC) are the type of enterprises with legal status recognized by law. Company owners and companies are two separate legal entities. Before the law, the company has the legal status from the date of issuance of the business registration certificates, and the company owner is the person with the rights and obligations corresponding to the ownership of the company.
- A private company (PC) is an economic organization that is permitted to register a business following regulations and conduct business activities. A private enterprise is owned by an individual who has assets and has a transaction office.

Therefore, the sample in this study consists of the three types of companies mentioned above. The data for this study were collected through questionnaires. To obtain data, the service quality model developed from the SERVQUAL model by Parasuraman et al. was modified to reflect textile activities and adopted. The questionnaire form was developed to test the ratings of perceptions of the distributors on the services tested.

The full survey, through the mailed questionnaire, was carried out within 2 months. Respondents were required to rate their perceptions of the various attributes for the service quality of textiles provided on a 5-point Likert scale.

Data envelopment analysis was then executed by using the pure output model, considering the five dimensions as outputs. The single constant input value of 10 was allocated to every DMU. DEA efficiency scores as measures of service quality (DEA-SQ) were then obtained for the 144 DMUs.

## 4 Results and discussion

### 4.1 Assessment of the scale

The items of the scale, along with their underlying factors, which are used to measure Service quality in the textile supply chain, are derived from the literature. Therefore, it is imperative to assess the scales.

Reliability analysis and confirmatory factor analysis (CFA) were performed for this purpose. The alpha coefficients for the 5 variables are higher than 0.8, suggesting that the items have relatively high internal consistency (Table 2).

**Table 2**. Results of the test for reliability analysis

| Variables | Cronbach's alpha | No. of items |
|---|---|---|
| Tangibles | 0.923 | 6 |
| Empathy | 0.902 | 8 |
| Assurance | 0.931 | 7 |
| Responsibility | 0.863 | 5 |
| Reliability | 0.875 | 5 |

### 4.2 Results and discussion

First of all, the data for the five dimensions of SERVPERF for 144 service units (SMEs in the textile industry) were randomly generated for perceptions. A uniform distribution from 1 to 5 was assumed to produce ratings with the five-point Likert scale. The five-point Likert scale from "Strongly Disagree (1)" to "Strongly Agree (5)" can be used for measurement. SERVPERF is the multiple-item scale composed of five dimensions and 31 items for measuring consumer perceptions of service quality (Table 3).

**Table 3.** Items description of five dimensions

| No | Variable description |
|---|---|
| TAN1 | 1. Up-to-date equipment and technology |
| TAN2 | 2. Physical facilities should be visually appealing |
| TAN3 | 3. Employees are well dressed and appear neat |
| TAN4 | 4. Physical facilities are kept |
| TAN5 | 5. Convenient location |
| TAN6 | 6. A good image in the marketplace |
| EMP1 | 7. Individual attention |
| EMP2 | 8. Employees do not give company personal attention |
| EMP3 | 9. Flexibility to change as per the needs of customers |
| EMP4 | 10. Having best interests at heart |
| EMP5 | 11. Operating hours convenient |
| EMP6 | 12. Supplying complete information to distributors and customers |
| EMP7 | 13. Reasonable cost, processing cost, transportation cost, final cost to the customer |
| EMP8 | 14. Ability to interact and understand customers need at different levels of the supply chain |
| ASS1 | 15. Trusting the employees |
| ASS2 | 16. Feeling safe in transactions |
| ASS3 | 17. Employees are polite |

| No | Variable description |
|---|---|
| ASS4 | 18. Employees get adequate support to do their job well |
| ASS5 | 19. The textile factory guarantee their competence |
| ASS6 | 20. The textile factory has good performance |
| ASS7 | 21. Assurance of product quality, delivery |
| RES1 | 22. Telling customers when services are performed |
| RES2 | 23. Giving prompt and consistency in performance, delivery |
| RES3 | 24. Being willing to provide solutions to customer problems |
| RES4 | 25. Being available to respond to customers' requests promptly |
| RES5 | 26. Willing to correct errors in the products delivered by supply chain |
| REL1 | 27. Sending product within a certain time, |
| REL2 | 28. When you have problems, the textile factory is sympathetic and reassuring |
| REL3 | 29. Dependable |
| REL4 | 30. Right time and right terms |
| REL5 | 31. Keeping records accurately |

Table 4 illustrates the description of the variables. From the means obtained, Assurance is the most important Textile service quality dimension. The next highest mean values are Empathy, Tangibles, and Responsiveness. Reliability scores the lowest because the distributors generally understand that it is very difficult for service provider's employees to cater to the individual needs of each distributor (Table 4).

Table 5 shows that the highest standard deviation for Tangible 4 reveals that the distributors highly evaluate the physical facilities. The distributors have the lowest perception in the ability to interact and understand customers' needs at different levels of the supply chain (Empathy 8).

**Table 4.** Description of five dimensions

| Variable | Mean | Std. deviation |
|---|---|---|
| Tangibles (6) | 22.1389 | 4.32526 |
| Empathy (8) | 26.6181 | 4.95574 |
| Assurance (5) | 25.2986 | 5.08540 |
| Responsiveness (5) | 17.8958 | 3.51365 |
| Reliability (5) | 17.8542 | 3.14891 |

**Table 5.** Descriptiion of 31 items

| Variables | | Mean | Std. deviation |
|---|---|---|---|
| **Tangibles** | TANG1 | 3.3819 | 0.96074 |
| | TANG2 | 3.9514 | 0.77847 |
| | TANG3 | 3.9236 | 0.61542 |
| | TANG4 | 3.6736 | 1.19340 |
| | TANG5 | 3.5833 | 0.67420 |
| | TANG6 | 3.6250 | 0.72782 |
| **Empathy** | EMP1 | 3.0278 | 0.89243 |
| | EMP2 | 3.2222 | 1.00658 |
| | EMP3 | 3.2292 | 0.94402 |
| | EMP4 | 3.3333 | 0.67937 |
| | EMP5 | 3.5000 | 0.67937 |
| | EMP6 | 3.3125 | 0.77069 |
| | EMP7 | 3.3611 | 0.76287 |
| | EMP8 | 3.6319 | 0.61162 |
| **Assurance** | ASS1 | 3.3403 | 1.05885 |
| | ASS2 | 3.9514 | 0.91093 |
| | ASS3 | 3.8889 | 0.59262 |
| | ASS4 | 3.5000 | 1.08389 |
| | ASS5 | 3.8194 | 0.73525 |
| | ASS6 | 2.9792 | 0.81480 |
| | ASS7 | 3.8194 | 0.73525 |
| **Responsiveness** | RES1 | 3.2292 | 0.93658 |
| | RES2 | 3.5069 | 0.98943 |
| | RES3 | 3.8611 | 0.77198 |
| | RES4 | 3.5694 | 0.89014 |
| | RES5 | 3.7292 | 0.75927 |
| **Reliability** | REL1 | 3.1111 | 0.86187 |
| | REL2 | 3.5139 | 0.88489 |
| | REL3 | 3.8611 | 0.75365 |
| | REL4 | 3.6875 | 0.66342 |
| | REL5 | 3.6806 | 0.66535 |

After the service quality in textile companies was measured by using SERVPERF, the construct validity of DEA – Service quality was examined along with the SERVPERF score

**Table 6.** The correlation between measures of SERVPERF and DEA

| **Correlation** | | | |
|---|---|---|---|
| | | **DEA-SQ** | **SERVPERF-SQ** |
| DEA-SQ | Pearson Correlation | 1 | 0.658 |
| | Sig. (2-tailed) | | 0.000 |
| | *N* | 144 | 144 |
| SERVPERF-SQ | Pearson Correlation | 0.658 | 1 |
| | Sig. (2-tailed) | 0.000 | |
| | *N* | 144 | 144 |

$p < 0.01$ level (2-tailed)

computed as the sum of the score of five dimensions. Table 6 shows the Pearson correlation coefficients among the two measures.

It is shown that SERVPERF-SQs are highly correlated with DEA-SQs, implying that both measures have high construct validity. The validity test presents that DEA-SQ is also a valid measure of overall service quality, and therefore it can be used for benchmarking service quality (Table 6).

The DEA results reveal that 29 out of 144 DMUs are efficient (Figure 3). The score in 115 inefficient SMEs is as follows: 72 SMEs have a score in range [0.9, 1]; 36 SMEs have a score in range [0.8, 0.9]; only 7 SMEs havea score less than 0.8 (Figure 4).

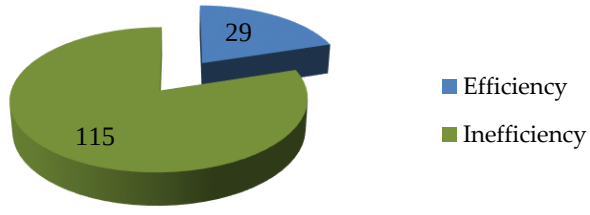


**Figure 3.** DEA results of 144 SMEs

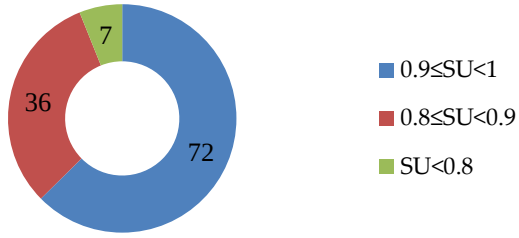


**Figure 4.** DEA results of 115 inefficient SMEs

Table 7 and Table 8 present the ten highest score and ten lowest score among inefficient DMUs with their actual scores across five dimensions. The last column presents the reference groups identified for benchmarking. Using the weights obtained for each efficient DMU composing the reference group, the number of improvements required to make an inefficient DMU efficient can be calculated. For DMU 26 with the lowest inefficiency score whose efficiency score is 0.688, for example, the reference group composed of DMU 52 (0.825) and DMU 65 (0.175) was identified. The highest inefficiency score (DMU 11) also conducts similarly with the lowest DMU. Combining the ratings of the two benchmarks with the weights yields the target values for improvement for each dimension, which, in turn, produces the required amount of improvements, as shown in Table 9 and Table 10.

**Table 7.** DEA data and results of 10 highest score among inefficiency DMUs

| DMU | Tangibles | Empathy | Assurance | Responsiveness | Reliability | Efficiency score | Reference group |
|---|---|---|---|---|---|---|---|
| SU92 | 4.2 | 4 | 2.7 | 4 | 3.8 | 0.996 | 134, 91, 15, 52 |
| SU25 | 4.2 | 4.3 | 4.1 | 2.6 | 4 | 0.995 | 52, 32, 123 |
| SU102 | 4.2 | 4 | 4.1 | 4 | 4 | 0.995 | 123, 94, 120, 77, 134 |
| SU99 | 2.8 | 3.6 | 4.6 | 3 | 4.6 | 0.994 | 118, 123, 49 |
| SU30 | 4.2 | 3.9 | 2.7 | 4.6 | 3.8 | 0.991 | 24, 134, 73 |
| SU55 | 3.3 | 3.6 | 3.9 | 4.6 | 4 | 0.988 | 49, 134, 94, 135 |
| SU67 | 3.3 | 2.8 | 4.1 | 3 | 4.8 | 0.983 | 49, 123, 120 |
| SU133 | 3.8 | 2.9 | 3.6 | 4.8 | 3 | 0.98 | 94, 27, 135, 73 |
| SU5 | 4.7 | 3.3 | 3.6 | 3.6 | 3.8 | 0.979 | 24, 52, 15, 65 |
| SU11 | 4 | 2.6 | 4.6 | 3 | 2.8 | 0.979 | 131, 44 |

**Table 8.** DEA data and results of 10 lowest score among inefficiency DMUs

| DMU | Tangibles | Empathy | Assurance | Responsiveness | Reliability | Efficiency score | Reference group |
|---|---|---|---|---|---|---|---|
| SU112 | 3 | 2.4 | 1.9 | 3.8 | 3.8 | 0.811 | 120, 49, 73 |
| SU4 | 3.3 | 3.1 | 2.7 | 3 | 3.8 | 0.804 | 123, 72, 120, 91, 134 |
| SU3 | 3.3 | 3 | 2.9 | 3 | 3.8 | 0.803 | 123, 134, 120, 72, 91 |
| SU31 | 1.8 | 3.6 | 3.6 | 3.2 | 3.2 | 0.798 | 123, 64, 94, 134 |
| SU63 | 2.8 | 2.9 | 3.6 | 3 | 3.6 | 0.792 | 72, 131, 49 |
| SU41 | 3.3 | 3.4 | 2.9 | 3.6 | 2.8 | 0.79 | 32, 134, 64, 94 |
| SU68 | 3.3 | 3.1 | 1.9 | 2.6 | 3.6 | 0.784 | 123, 134, 91, 52 |
| SU9 | 1.8 | 3.4 | 3.6 | 2.8 | 3.6 | 0.778 | 123, 131, 49, 118 |
| SU117 | 1.8 | 3.3 | 3.6 | 3 | 2.8 | 0.768 | 123, 32, 94, 59 |
| SU26 | 3.3 | 2.4 | 1.9 | 1.6 | 2.6 | 0.688 | 52, 65 |

**Table 9.** Benchmarking of SU26 (lowest inefficiency score among inefficiency DMUs

| | TAN | EMP | ASS | RES | REL |
|---|---|---|---|---|---|
| SU52 (0.825) | 4.8 | 3.9 | 4.1 | 2.8 | 4 |
| SU65 (0.175) | 4.8 | 2.9 | 4.0 | 3.8 | 4.2 |
| Improvement target | 4.83 | 3.70 | 4.12 | 2.98 | 4.04 |
| SU26 | 3.3 | 2.4 | 1.9 | 1.6 | 2.6 |
| Improvement require | 1.5 | 1.3 | 2.2 | 1.4 | 1.4 |

**Table 10.** Benchmarking of SU11 (highest inefficiency score among inefficiency DMUs)

| | TAN | EMP | ASS | RES | REL |
|---|---|---|---|---|---|
| SU131 (0.488) | 4.2 | 3.6 | 4.7 | 3.8 | 4 |
| SU44 (0.512) | 4.3 | 4.0 | 4.7 | 3.6 | 2 |
| Improvement target | 4.25 | 3.82 | 4.71 | 3.70 | 2.98 |
| SU11 | 4 | 2.6 | 4.6 | 3 | 2.8 |
| Improvement require | 0.3 | 1.2 | 0.1 | 0.7 | 0.2 |

## 5 Conclusions and implications

The contribution of this research to the academic field is multi-fold. Firstly, this study fills the existing gap in the literature, in which research in the field of service quality in the manufacturing sector, in general, and the textile industry, in particular, is scant. Secondly, this study conceptualizes and validates a service quality model specifically for the textile industry, and this supports most other scholars' belief that the SERVPERF model, although popularly used in various contexts, cannot be a one-size-fits-all model to all sectors and situations. Besides, the findings shed valuable insights on measures and critical underlying dimensions of service quality in the context of the supply chain in the textile industry, specifically from the distributor perspective. These can have immense use not only for researchers but also for marketing professionals. The proposed model provides a deeper understanding of the relationships between key factors and overall service quality of the supply chain in Vietnam's textile industry. This study also attempts to bridge the gap in the extant literature on managers' perceptions of supply chain service quality in Vietnam. The application of DEA-SERVPERF provides additional insights into the management of service quality. However, it must be recognized that this research also has several limitations. Although the results give the best performers in the SMEs of textile companies and the guideline for the inefficient DMUs to improve each dimension, the main dimensions to affect the overall service quality are not considered. This study uses the survey method that is restricted to South Vietnam, while the application of this methodology in other regions may change the predicted results of this study.

## References

1. Abdullah, F. (2006), Measuring service quality in higher education: HEdPERF versus SERVPERF, *Marketing Intelligence & Planning*, 24(1), 31–47.
2. Adler, N. & Berechman, J. (2001), Measuring airport quality from the airlines' viewpoint: An application of data envelopment analysis, *Transport Policy*, 8(3), 171–181.
3. Altuntas, S., Dereli, T. & Yilmaz, M. K. (2012), Multi-criteria decision-making methods based weighted SERVQUAL scales to measure perceived service quality in hospitals: A case study from Turkey, *Total Quality Management & Business Excellence*, 23(11/12), 1379–1395.
4. Andersen, P. & Petersen, N. C. (1993), A procedure for ranking efficient units in data envelopment analysis, *Management Science*, 39(10), 1261–1264.
5. Babakus, E. & Boller, G. W. (1992), An empirical assessment of the Servqual scale, *Journal of Business Research*, 24(3), 253–268.
6. Banker, R. D., Charnes, A. & Cooper, W. W. (1984), Some models for estimating technical and scale inefficiencies in data envelopment analysis, *Management Sciences*, 30(9), 1078–1092.
7. Banker, R. D. & Morey, R. C. (1986), The use of categorical variables in data envelopment

analysis, *Management Science*, 32(12), 1613–1627.

8. Belton, V. & Vickers, S. P. (1993), Demystifying DEA: A visual interactive approach based on multi-criteria analysis, *Journal of the Operational Research Society*, 44(9), 883–896.
9. Bouyssou, D. (1999), Using DEA as a tool for MCDM: Some remarks, *Journal of the Operational Research Society*, 50(9), 974–978.
10. Brown, T. J., Churchill, G. A., Jr. & Peter, P. J. (1993), Improving the measurement of service quality, *Journal of Retailing*, 68(1), 127–139.
11. Calvo-Porral, C., Lévy-Mangin, J. P. & Novo-Corti, I. (2013), Perceived quality in higher education: An empirical study, *Marketing Intelligence & Planning*, 31(6), 601–619.
12. Carman, J. M. (1990), Consumer perceptions of service quality: An assessment of the SERVQUAL dimensions, *Journal of Retailing*, 66(1), 33–35.
13. Carrillat, F. A., Jaramillo, F. & Mulki, J. P. (2007), The validity of the SERVQUAL and SERVPERF scales: A meta-analytic view of 17 years of research across five continents, *International Journal of Service Industry Management*, 18(5), 472–490.
14. Charnes, A., Cooper, W. W. & Rhodes, E. (1978), Measuring efficiency of decision-making units, *European Journal of Operational Research*, 2(6), 429–444.
15. Chow, C. C. & Luk, P. (2005), A strategic service quality approach using analytic hierarchy process, *Managing Service Quality*, 15(3), 278–289.
16. Cook, W. D., Kress, M. & Seiford, L. M. (1996), Data envelopment analysis in the presence of both quantitative and qualitative factors, *Journal of the Operational Research Society*, 47(7), 945–953.
17. Cook, W. D., Tone, K. & Zhu, J. (2014), Data envelopment analysis: Prior to choosing a model, *Omega*, 44, 1–4.
18. Cook, W. D. & Zhu, J. (2006), Rank order data in DEA: A general framework, *European Journal of Operational Research*, 174(2), 1021–1038.
19. Cooper, W. W., Seiford, L. M. & Tone, K. (2000), *Data envelopment analysis: Theory, methodology, and applications, references and DEA-solver software*, Boston: Kluwer Academic Publishers.
20. Cronin, J. J., Jr. & Taylor, A. S. (1992), Measuring service quality: A reexamination and an extension, *Journal of Marketing*, 56(3), 55–67.
21. Cronin, J. J., Jr. & Taylor, A. S. (1994), SERVPERF versus SERVQUAL: Reconciling performance-based and perception-based – minus – expectation measurements of service quality, *Journal of Marketing*, 58(1), 125–131.
22. Donthu, N., Hershberger, E. K. & Osmonbekov, T. (2005), *Benchmarking marketing*.

productivity using data envelopment analysis, *Journal of Business Research*, 58(11), 1474–1482.

23. Doyle, J. & Green, R. (1993), Data envelopment analysis and multiple criteria decision

making, *Omega*, 21(6), 713–715.

24. Gronroos, C. (1990), *Service Management and Marketing: Managing the Moments of Truth in Service Competition*, Lexington Books, Lexington, MA.
25. Gummesson, E. (1991), Marketing-orientation revisited: the crucial role of the part-time marketers, *European Journal of Marketing*, 25(2), 60–75.
26. Jain, S. K. & Gupta, G. (2004), Measuring service quality: SERVQUAL vs SERVPERF scales, *Vikalpa*, 29(2), 25–37.
27. Kettinger, W. J. & Lee, C. C. (1997), Pragmatic perspectives on the measurement of information systems service quality, *MIS Quarterly*, 21(2), 223–240.
28. Lee, H. & Kim, C. (2012), A DEA-SERVQUAL approach to measurement and benchmarking of service quality, *Procedia - Social and Behavioral Sciences*, 40, 756–762.
29. Lovell, C. A. K. & Pastor, J. T. (1997), Target setting: An application to a bank branch network, *European Journal of Operational Research*, 98(2), 290–299.
30. Lovell, C. A. K. & Pastor, J. T. (1999), Radial DEA models without inputs or without outputs, *European Journal of Operational Research*, 118(1), 46–51.
31. Mentzer, J. M. (2004), Global market segmentation for logistics services. *Industrial Marketing Management*, 33, 15-20.
32. Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1985), A conceptual model of service quality and its implications for future research, *Journal of Marketing*, 49(3), 41–50.
33. Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1988), SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality, *Journal of Retailing*, 65(1), 12–40.
34. Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1994), Reassessment of expectations as a comparison in measuring service quality: Implications for further research, *Journal of Marketing*, 58(1), 111–124.
35. Ramanathan, R. (2006), Data envelopment analysis for weight derivation and aggregation in the analytic hierarchy process, *Computers and Operations Research*, 33(5), 1289–1307.
36. Rust, R.T. and Oliver, R. L. (1994), *Service quality: insights and managerial implications from the frontier, in Rust, R.T. and Oliver, R.L. (Eds), Service Quality: New Directions in Theory and Practice*, Sage Publications, London, 1–20.
37. Seth, N., Deshmukh, S. G. & Vrat, P. (2005), Service quality models: A review, *International Journal of Quality & Reliability Management*, 22(9), 913–949.
38. Seth, N., Deshmukh, S.G. and Vrat, V. (2006), A conceptual model for quality of service in the supply chain, *International Journal of Physical Distribution and Logistics Management*, 36(7), 547–75.
39. Spendolini, M. J. (1992), *The benchmarking book*, New York: American Management

Association.

40. Stewart, T. J. (1996), Relationships between data envelopment analysis and multicriteria decision analysis, *The Journal of the Operational Research Society*, 47(5), 654–665.
41. Tarun K. Gupta, Vikram Singh (2012), Service Quality in Supply Chain: A Review, *International Journal of Engineering and Technology*, 2(8), 1395–1404.
42. Van Dyke, T. P., Kappelman, L. A. & Prybutok, V. R. (1997), Measuring information systems service quality: Concerns on the use of the SERVQUAL questionnaire, *MIS Quarterly*, 21(2), 195–208.
43. Yang, T. & Kuo, C. (2003), A hierarchical AHP/DEA methodology for the facilities layout design problem, *European Journal of Operational Research*, 147(1), 128–136.
44. Zeithaml, V. A. (1988), Consumer perception of price, quality and value: a means-end model and synthesis of evidence, *Journal of Marketing*, 52(3), 2–22.
45. Zhou, L. (2004), A dimension-specific analysis of performance-only measurement of service quality and satisfaction in China's retail banking, *Journal of Services Marketing*, 18(6/7), 534–546.