Linking dimensions of service quality to organizational outcomes

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Keywords

Service quality assurance, Data encapsulation, Retailing, Benchmarking

Abstract

While market theorists have devoted a great deal of effort to the conceptualization of service quality, the practical guidance available to service providers continues to be very limited. Utilizing the emerging role of a new marketing entity, the retail electric service provider, as an illustration, the article discusses how data envelopment analysis might be used to analyze service quality at the retail service level. Specific dimensions thought to influence consumers' perceptions of the quality of retail electric energy services are identified, and the potential use of data envelopment analysis as a diagnostic tool for effective management of service quality by retail electric service providers is demonstrated. Generalization to different types of service providers is suggested. Empirical studies to develop practical guidance along this line of analysis are encouraged.

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Managing Service Quality
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Introduction

Service quality has long been recognized as an important issue in both the public and private sectors in the USA, but, in recent years, even greater attention has been focused on the concept. The growing importance of service quality in the public sector is underlined by the emphasis on re-engineering of government at the federal level as well as the move to performance budgeting and service efforts and accomplishments reporting at the state and local levels (Halachmi, 1997). Likewise, in the private sector (for-profit as well as not-for-profit), service quality grows more important daily as service providers face more efficient and effective market competition, both locally and globally.

The purpose of this paper is to suggest a unique application of data envelopment analysis to the diagnosis and management of service quality issues. To illustrate the application, the authors consider the role of the retail electric service provider in the changing US electric energy market. First, we identify a specific set of service quality dimensions likely to be most pertinent to the retail electric service provider. Then, we discuss the effective use of this conceptual framework utilizing data envelopment analysis as a diagnostic tool. This is thought to be the key contribution of the paper. While others have demonstrated the potential operationalization of the service quality construct in a variety of industries, few have discussed in depth how this information, once gathered, might be analyzed. Likewise, the process of managing service quality has not been directly linked to key organizational performance benchmarks. The authors will discuss how data envelopment analysis can be used to accomplish both. But first, we turn to the new role of the electric service provider in the US retail electric market to develop a frame of reference.

The role of the retail electric service provider in a restructured market

Spanning both the public sector and the private sector, the US electric energy market has recently undergone substantial regulatory

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

change as the result of both federal and state-level initiatives to introduce market competition. In a complex deregulation movement, a new breed of retail electric service provider is being spawned by the ongoing restructuring. The Energy Information Administration (2000, pp. 1, 24) suggests in *The Restructuring of the Electric Power Industry: A Capsule of Issues and Events*, that:

> The industry is currently in the midst of a transition from a vertically integrated and regulated monopoly to an entity in a competitive market where retail customers choose the suppliers of their electricity .... In 1996, California and Rhode Island passed landmark legislation to restructure their electric power industries and give their consumers the right to choose the supplier of their electricity .... To date, 24 states have passed similar legislation or regulatory orders that will allow retail access to electricity. Most of the remaining states ... are actively investigating the issues and observing the states that have begun retail access. Many ... will likely enact laws in the next few years .... Consumers are being offered lower prices from their incumbent utilities through legislative provisions and a choice of alternative suppliers that offer a variety of electricity products and services ....

The impact of such legislative and rule-making deregulation and the resultant increases in market competition on a widening scale have serious implications for present and emergent electric service providers. Given the fact that there currently seems to be an irreversible trend toward market competition and a pro-market philosophy to solve virtually all public policy problems in the USA (McSwite, 2002), adequately meeting citizen/consumer needs and desires under more competitive conditions is likely to become increasingly important to US retail marketers of electric energy, both public and private.

In common historical industry parlance, the electric industry has been vertically segmented into generation, transmission and distribution. This, too, is changing (Brennan *et al.*, 1996). The Energy Information Agency (2000, p. 13) suggests:

> The distribution function will typically operate as a monopoly and the state utility commission will continue to regulate it as such .... However, the distribution company will have a different role from its current one. Its main obligation in the future will be to assure that customers are connected to the distribution system. This differs from the prior obligation of the electric monopoly supplier, which was to assure not only connection and delivery, but electricity services as well.

Thus, under the new structural arrangements, the role of the traditional electric distributor is being redefined, and, its historic function is being conceptually segmented into connection and delivery on the one hand, and electricity service on the other (Energy Information Agency, 2000). While, in all cases, the physical distribution of electricity will remain the function of the traditional regulated distributor utility, the sale of electricity is being "unbundled" from the package of services historically performed by this entity. The package of electricity services may, or may not, continue to be provided by the distributor in conjunction with its newly redefined role. In the alternative, emergent electric service providers will compete with the distributor for the electricity service role. In this market scenario, the sale of electric energy will be in a competitive market. "Re-bundled" service packages might include "billing, metering, and associated consumer services" (Energy Information Agency, 2000, p. 40) along with other services. As a matter of fact:

> ... many suppliers have pointed out that their motivation to sell electricity to low usage consumers may be greatly influenced by their ability to market additional ... services to them (Energy Information Agency, 2000, p. 41).

In response to this increased competition, both public sector and private sector organizations are attempting to better position themselves by cutting costs and becoming more customer-oriented. Some providers of electricity are trying to increase the range of services they currently offer customers in an effort to increase customer loyalty. Others are offering "environmentally correct electricity" (Kerber, 1997). Practitioners in the field have begun to realize that offering electric services high in quality will be a vital skill necessary for creating and maintaining a competitive advantage (Commonwealth of Virginia: State Corporation Commission, 1996).

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

Service quality in the retail electric industry: a theoretical grounding

Service quality has been defined as:

> ... a consumer attitude reflecting the perceived overall superiority and excellence in the process and outcome of a service provider (Parasuraman *et al.*, 1988, p. 15).

While this definition seems straightforward, determining the process by which such attitudes are formed has proven to be a very difficult task. In fact the basic conceptualization of service quality has evolved significantly over the years. In contrast to its initial, simpler conceptualizations (Cardozo, 1965; Grönroos, 1984), today, service quality is generally believed to be a multi-level construct with multiple dimensions making up each level (Dabholkar *et al.* 1996; Brady and Cronin, 2001). Understandably, scales purported to measure service quality have also evolved and while, to date, no generic measure of service quality suitable for all industries has emerged, several industry-specific measures of service quality have been created and shown to be quite effective (Dabholkar *et al.*, 1996; McAlexander *et al.*, 1994).

For example, Babakus and Boller (1992) examined the extent to which service quality for electric services could be adequately measured using the SERVQUAL scale. This scale conceptualizes service quality as a function of five basic dimensions:

(1) the reliability with which the service is provided;
(2) the assurance customers receive that they are purchasing the best possible service;
(3) the tangible features of the service experience;
(4) the empathy employees show customers; and
(5) the responsiveness of service personnel (Parasuraman *et al.*, 1988).

Along with a number of other problems, these researchers found that the conceptualized dimensionality of the construct did not hold for their sample of customers. Rather than finding evidence that the items represent five, distinct dimensions of service quality, they found the items loaded on only two factors: one representing the negatively-worded items in the scale and one representing the positively-worded items in the scale. Based on this finding, these theorists suggest that the service quality construct in the context of the electric utility industry has a simpler domain than in other industries. They suggest it is basically one-dimensional.

Another possible explanation for this finding, however, is that the SERVQUAL scale did not tap the relevant dimensions leading to service quality in the electric industry. On examination of recent survey efforts conducted in the field, it appears that practitioners and industry researchers have begun to focus more attention on the question of how consumers evaluate the quality of their electric service provider. Recent reports of survey efforts by practitioners provide preliminary evidence that a different model of service quality might be more appropriate for the electric industry (e.g. Holcomb, 1993). Generally, the issues addressed can be sorted into five, distinct categories: personal interaction, reliability, problem solving, policy and physical aspects. These are roughly the same categories as the service quality dimensions identified by Dabholkar *et al.* (1996), where they conceptualize service quality in the more general retail industry:

- *Dimension 1.* Personal interaction with the customer.
- *Dimension 2.* Reliability of service delivery to the customer.
- *Dimension 3.* Problem solving for the customer.
- *Dimension 4.* Policy issues with respet to the customer
- *Dimension 5.* Physical aspects of the relationship with the customer.

Given this observed similarity, it seems reasonable to suspect that service quality of the retail electric service provider might accurately be captured by the Dabholkar *et al.* (1996) dimensions. The relevance of each of these five retail dimensions as they relate to the provision of electric service and electric distribution is discussed.

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

Five dimensions of service quality for the retail electric service provider

Dimension 1. Personal interaction in service provision

Babakus and Boller (1992) suggest consumers do not regularly have close contact with their electric service provider. This seems to imply that personal interactions among electric service personnel and customers would not significantly influence service quality perceptions. However, findings from a study conducted by the Edison Electric Institute (Gellings, 1994) indicate otherwise. Here, it is reported that consumers view electric services as both a product and a service where consumers not only evaluate the product purchased in terms of costs, value and controllability, they evaluate the level of service received "based on the utility's interactions with them and their neighbors" (Gellings, 1994, p. 224). Thus, personal interactions appear, in fact, to be a key determinant of perceived service quality in the case of both the physical distributor of electricity as well as the electric service provider.

Dabholkar *et al.* (1996) suggest that in a retail service situation, personal interactions give employees the chance to instill confidence in customers that they have made the right choice about where to shop. Also, it allows employees to demonstrate their ability to help the consumer with questions or problems. It seems reasonable that this dimension would also play a role in determining the service quality of an electric service provider. In fact, the findings from the Edison Electric Institute (Gellings, 1994) suggest it is from these interactions that consumers judge the extent to which the utility cares about them and values their business.

It has also been suggested that customers welcome the opportunity to talk with knowledgeable utility service representatives (Gellings, 1994). And while, as above, Babakus and Boller (1992) note that utility consumers have relatively little close contact with their service provider, there are, nonetheless, a number of occasions when personal interactions with utility personnel are necessary. Not only is the successful delivery of electric service typically contingent on initial interactions between the prospective customer and the service provider, the customer must contact the utility when the service hook-up is transferred from one address to another, when there is a power outage due to inclement weather or other naturally occurring event, when there is an engineering or technical malfunction of the system, or when power has been cut off because of late payment or the occurrence of some administrative error. Whether these interactions occur by telephone, face-to-face or on an interactive Web page, the extent to which electric service personnel exhibit the ability to handle such matters effectively, and whether they appear to care about tending to the consumer's request, should impact perceptions of service quality.

It also seems reasonable to expect that personal interactions between consumers and personnel of distributors and electric service providers will become increasingly important as these organizations continue to expand the existing range of services they offer. Gellings (1994) reports some electric service providers have begun to sell and install heat pumps, others lease equipment to consumers, while others have actually begun to offer consulting services to consumers. It is not unusual for utilities to provide financing for the purchase of large appliances by electric customers. In each of these cases, interactions, much like those of a retail store, will take place and should significantly influence consumers' perceptions of overall service quality.

Dimension 2. Reliability of service

Reliability basically refers to the extent to which the retail service provides what was promised when it was promised (Dabholkar *et al.*, 1996). Clearly, it can be argued this dimension plays a significant role in the sale and delivery of electric service. Typically, electric service provision is described as continuous (Babakus and Boller, 1992) and, distributor/providers are expected to provide for the delivery of power without interruption. The extent to which such provision is continuous should be a good indicator of reliability.

The importance of this dimension as a determinant of service quality is suggested in a number of ways. In the largest sense, the very existence of the National Electric Reliability Council, which was established in 1968, can be

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

understood as an indicator of the importance of electric service reliability. The basic purpose of the council is to increase the reliability and adequacy with which bulk power is supplied throughout the North American utility system. In addition, a major provision of the Public Utilities Regulatory Policies Act of 1978, was to require that standards be established indicating exactly what level of reliability should be maintained to adequately meet the needs of consumers (Gonen, 1988).

Electric utilities have used an index of reliability (the proportion of uninterrupted customer hours provided per year out of the total number of customer hours provided per year) as a positive system performance measure (Gonen, 1988). And, Gellings (1994) reports that a series of focus groups and in-depth interviews conducted by the Empire State Electric Energy Research Corporation indicated the reliability with which electric service is provided is, indeed, a concern. Here, consumers described four or more "outages" (that is, service interruptions) per year as undesirable. The question is, will the reliability dimension fall on the distributor or the retail service provider. According to the Office of Energy Efficiency and Renewable Energy (OEERE), United States Department of Energy (Alexander, 1998, p. 28):

> Distribution utilities will remain responsible for most aspects of power quality because of their retained ownership of the distribution system, that is the poles and wire that deliver electricity to each customer's home and place of business ... [they] will remain responsible for service reliability (outages, their frequency and duration), installation of service (service drops, as well as line extensions in previously un-served areas) ....

From this, it appears that the distributor, as distinguished from the electric service provider, will shoulder the major burden of reliability, since it relates directly to the physical distribution of electric energy. There are, however, important ways in which an electric service provider might demonstrate the reliability of its services. The service provider may agree to arrange for energizing electric service for a new customer on a specified date. In many cases, extensive construction, complex legal agreements, or both, may be required before service can be established in accordance with the terms agreed to by the retail customer, the electric distributor and the service provider. This may, in turn, call for high-quality planning and scheduling of work on the part of both the service provider and the distributor because of the need to coordinate highly-trained employees, legal advisors, engineers, heavy equipment and, perhaps, even contractors. Because of the high visibility of these activities and due to the fact that the timely availability of electric service to customers is important, even critical in some cases, meeting commitments with respect to the promised service date in a highly organized fashion will influence consumer perceptions in an important way.

Likewise, as the range of services offered by electric service providers broadens, there will become an increasing need to send personnel into consumers' businesses and homes (e.g. heat pump installation, equipment maintenance and repair, safety light installation, etc.). Some providers may bundle electric service provision with energy management services. As the number of these service occasions increases, there will be a substantial need to coordinate the schedules of service personnel and consumers so that the consumer is served with the least annoying intervention. The extent to which service personnel consistently, and conveniently, arrive and carry out their duties as scheduled should impact consumer perceptions of service reliability, not only in the case of the electric distributor, but the service provider, as well.

Dimension 3. Problem solving in service provision

The problem-solving ability of a retail service is primarily determined by the extent to which the establishment is able to make service recoveries (Dabholkar *et al.*, 1996). In the broadest sense, this includes the manner in which returns, exchanges and complaints are handled by store personnel. Clearly, there is an impact of these activities on consumers' perceptions of quality. Just as these issues require the prompt attention of other retailers, electric utilities and electric service providers must also attend to service recovery. For instance, sometimes a customer might suspect that a bill has an error in it or that the electric meter at the service location is faulty. Only through the prompt attention of

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

utility or service provider personnel, can such issues be resolved satisfactorily. Although, as we note, the OEERE (Alexander, 1998, p. 28) has suggested that:

> ... distributor utilities will remain responsible for ... service disconnection, complaint resolution, change-orders, and billing and collection ...

this is not always the case. For example, in the same OEERE study, we find that California has ordered so-called:

> ... revenue cycle services (billing, metering and consumer services) be subject to competition for large customers in 1998 and for residential and small commercial customers beginning in 1999. Maine's electric restructuring legislation mandates that billing and metering competition commence no later than 2002 ... [in Pennsylvania], the recent PECO Energy restructuring plan settlement calls for billing and metering competition in that utility's service territory beginning in 1999. Massachusetts' legislation requires a study of metering, customer billing and information services competition by January 2001 (Alexander, 1998, p. 38).

Problem solving with regard to billing, information and other customer services, may fall on either the electric distributor or the electric service provider, depending on the specifics of the controlling set of regulatory structures, regulatory rulings and even contractual arrangements.

Another obvious, and potentially costly, service recovery opportunity arises when power outages occur due to electric system damages resulting from uncontrollable, natural phenomena. A utility company that is able to have the power back on shortly after a major outage caused by hurricane or earthquake would be thought to provide a higher quality service than one in which, *ceteris paribus*, the resulting outage lasts long periods of time. Gellings (1994) reports consumers are, not surprisingly, concerned about how long power outages last. While, generally, as noted above, this problem might be thought of as falling on the electric distributor alone, one can easily conjure up trilateral contractual relationships between retail customers, electric service providers and electric distributors, in which electric service interruptions would impact the perceived service quality of the electric service provider as well as the electric distributor.

Dimension 4. Policy choices in service provision

Dabholkar *et al.* (1996) suggest that the extent to which a store's policies influence consumer quality perceptions is directly related to whether the adopted policies meet customers' needs. For instance, providing convenient hours will influence consumers' quality perceptions. Likewise, offering customers access to credit cards that simplify the purchase transaction is seen as a policy issue that influences perceptions of service quality. Here again, similar features which relate to the provision of electric services would be expected to influence electric consumers' quality perceptions (Gellings, 1994).

There are a number of policy choices that the electric service provider must make with respect to meeting customer needs in this area. These include providing for electronic payment transfer, providing convenient drop-off points for in-person payments and provision of convenient hours of collection. Also, with respect to service initiation, is the customer required to be present in the supplier's office to apply for service; and, are special documentation and/or difficult to locate records required in order to have the electric service activated? In some instances, providers will offer consumers the opportunity to donate funds to help needy customers pay their electricity bills. OEERE (Alexander, 1998), suggests a list of contractual issues that should be considered by state regulators with respect to minimal requirements to be imposed on electric service providers. This list implies a number of policy areas that could impact service quality with respect to electric service providers:

- late fees;
- notice of renewal;
- length of contract term;
- collection costs;
- payment arrangements;
- notice of cancellation;
- medical emergency;
- pre-payment meters;
- deposits;
- rights of rescission; and
- dispute resolution.

One would expect that the extent to which an organization's policies respond to customer

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

needs in each of these areas would be an important factor in the customers' perceptions of service quality.

Dimension 5. Physical aspects of service provision

Finally, the appearance of the store and the convenience of its layout are physical aspects of a retail service which impact perceived service quality (Dabholkar *et al.*, 1996). Traditionally, consumers of electric services, unlike most retail consumers, have not been expected to regularly visit the location from which the electric utility operates; thus, they may not be thought to develop strong opinions about the appearance of the facility itself. Customers do, however, need to interact with their electric service provider under some circumstances. A physical presence, then, becomes important. One is reminded of the trend in telecommunications in this respect: does the provider operate from a small kiosk in the local shopping mall manned only in the afternoons by a part-time high-school student, or is the office maintained in a manner to suggest more stability and permanence? Is the office located in the vacated space of the recently failed body tanning shop, or is it located in the local corporate executive park? Surely, such physical aspects of the electric service provider will have an impact on perceived service quality. The derogatory phrase, "fly by night" comes to mind.

On a more global scale, with electric generation accounting for more than one-third of carbon dioxide emissions in the USA (Kerber, 1997), those concerned about the "greenhouse effect" are likely to link "environmentally friendly" electricity with the physical aspects of service quality. Kerber (1997, p. B1) reports:

> ... suppliers, including Enron Corp., Central Maine Power Co., and Green Mountain Power Corp., are plunging into the new era of competition with a delicate marketing tactic: wooing "green" consumers with energy billed as environmentally friendly.

Given the deregulated wholesale market for electric generation that presently exists, independent electric service providers will be able to capitalize on this and other environmental concerns. Physical aspects of electric service provision thus would seem to provide multiple options for service quality competition.

Marginal tradeoffs among service quality dimensions

It has been suggested elsewhere that, as the electric industry emerges into an increasingly competitive environment, practitioners should welcome the further development of analytical methods that provide new insights into improved management techniques (Tankersley and Tankersley, 1996). Unfortunately, with respect to service quality management, theoretical guidance presently available to practitioners is very limited. For example, it has yet to be determined how the various dimensions of service quality actually interrelate to form the overall level of service quality for the organization (Parasuraman *et al.*, 1991). Can high performance on one dimension compensate for low performance on another? Without knowledge of these, and similar, questions, it is difficult to formulate meaningful strategic guidelines for management use in the effort to improve current service quality levels. This is the case even if the dimensions have been correctly specified and perceived service quality performance measured.

Recognizing the dearth of theory focusing on this particularly significant linkage, a few management scholars have begun to make suggestions as to how service quality data might be used to shape the strategy of the organization. For instance, Parasuraman *et al.* (1988) make several recommendations relating directly to SERVQUAL results. One is that survey results might be used to compare service quality performance across various units within an organization (e.g. different stores in a chain) or across competitors in an industry. Another recommendation is to use regression analysis to determine the relative impact of each service quality dimension on overall service quality. The model would be estimated by regressing the average performance score for each of the dimensions of service quality on an overall service quality rating obtained from each individual surveyed (Parasuraman *et al.*, 1988). Unfortunately, the value of this information is quite minimal. At least two key questions

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

remain un-addressed, both resulting from the need to establish the direct linkage between specified dimensions of service quality on the one hand, and actual service performance outcomes, on the other. We turn now to these questions.

First, consider the level at which the service provider should strive to perform on each service quality dimension. While regression analysis has the potential for identifying relatively important dimensions, this information would not indicate how managerial and/or organizational behavior should be strategically modified to improve operating results. Are resources to be devoted entirely to improving performance on the most influential dimension? The two most influential? The three most?

Second, inherent in the regression analysis approach is the assumption that the manager's goal is to effectively manipulate various elements, or dimensions, of service quality to maximize the overall measure of service quality. Since it has generally been accepted that high levels of service quality are associated with high levels of organizational performance (Bolton and Drew, 1994), this is not an entirely unreasonable position to take. Realistically, however, service quality itself is generally not the ultimate managerial, or organizational, goal. While it has been suggested that there is an optimal level of service quality that each service provider should try to obtain, marginally diminishing returns are encountered (Rust and Oliver, 1994; Anderson *et al.*, 1994). Stated in terms of not only the ultimate goals of the service provider, but those of the consumer as well, at some point, the incremental costs of increased service quality simply outweigh the incremental benefits. This is a point often overlooked in conventional wisdom regarding quality. Given this, perhaps a better approach to the management of the various dimensions of service quality in both public sector and private sector organizations, is to link the service quality dimensions, themselves, directly to the ultimate goal of organizational marketing practice; that is, the maintenance of a healthy organization by adequately meeting customers' needs and desires (Gellings, 1994). An ideal technique for this purpose would allow managers to link different levels on the various dimensions of service quality to specific output or outcome measures that service providers and consumers do, unequivocally, intend to maximize. Data envelopment analysis can provide this linkage.

Linking service quality dimensions to service quality outcomes: the utility of data envelopment analysis

Data envelopment analysis has become very popular, multi-purpose methodology among those interested in measuring the relative efficiency of comparable decision-making units (DMUs). Cooper *et al.* (2000) note in the Preface to their recent text, *Data Envelopment Analysis: A Comprehensive Text with Models, Application, References and DEA-Solver Software*, that:

> Recent years have seen a great variety of applications of DEA (Data Envelopment Analysis) for use in evaluating the performances of many different kinds of entities engaged in many different activities in many different contexts in many different countries (Cooper *et al.*, 2000, p. xviv)

Verification is provided by these authors who include a bibliography comprised of some 1,500 DEA studies in the CD-ROM included with their text.

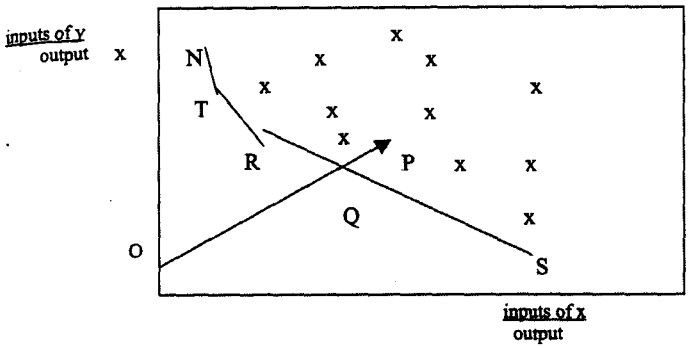
A useful overview of the DEA technique is given by de Lancer (1999) in *Data Envelopment Analysis: An Introduction*, where she says:

> DEA is an application of linear programming that measures the efficiency of any DMU as the maximum of a ratio of weighted outputs to weighted inputs subject to the condition that the similar ratios for every DMU be less than or equal to unity. DEA measures the "relative efficiency" of DMUs producing similar outputs and using similar inputs. It is called "relative efficiency" because a hypothetical composite DMU is constructed based on all DMUs in the reference group (de Lancer, 1999, p. 535).

A two-dimensional example similar to that displayed in Figure 1 is commonly found in the DEA literature to demonstrate what this efficiency score reflects. (For a comprehensive and state-of-the-art explanation of the DEA mathematical algorithm, see Nyhan and Martin (1999), Charnes *et al.* (1994), Cooper *et al.* (2000), and de Lancer (1999).) The

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

Figure 1 Farrell's (1957) Technical Efficiency



Source: Adapted from Nyhan and Martin (1999) and de Lancer (1999)

coordinates of the 17 DMUs depicted in Figure 1 represent the amount of each of two inputs that were used to obtain one unit of output by each DMU. Thus, by definition, the organizations found to be closest to the origin are those which are operating most efficiently, since they are using less input to produce one unit of output. The isoquant, NS, is comprised of piecewise linear segments connecting the efficient organizations and defines the "efficient frontier". This isoquant reflects the set of possible combinations of the two inputs an organization might hypothetically use to achieve one unit of output while being defined as relatively efficient with respect to the other organizations in the analysis. Those organizations on this frontier are thought to be the "best performers", while those outside this frontier are thought to be operating relatively inefficiently. The DEA algorithm produces scores for the inefficient DMUs (range: 0.00 to 1.00) which indicate how inefficient each is relative to the actual performance of similar, but efficient, DMUs.

The efficient frontier and the corresponding efficiency scores for the service quality application to electric service providers would be, conceptually, equivalent to this two-dimensional example. Technically, however, with multiple inputs and multiple outputs, as more fully described below, the piecewise linear segments defining the efficiency frontier are replaced with efficient "facets" due to the multi-dimensional nature of the example (Tankersley, 2000).

To relate DEA to our discussion of retail electric supplier service quality dimensions, and to demonstrate data envelopment analysis as a diagnostic tool for use in management decision making regarding the various dimensions of retail electric service quality, let us assume that an electric service provider is interested in diagnosing service quality issues for its regional sub-units (i.e. DMUs). The goal is to identify high-performing sub-units and low-performing sub-units with respect to efficient utilization of service quality efforts based on reported levels for each of the five dimensions of service quality. Consider the inputs and outputs listed in Table I.

The inputs are the dimensions identified previously to measure customers' service quality perceptions for each sub-unit of the electric service provider under review. Significant variances in the ratios of important outputs to these service quality inputs across regional DMUs should be of compelling interest to marketing managers. It has been suggested the key to long-term financial health of the organization is "efficiency in acquiring and retaining customers" (Anderson and Fornell, 1994, p. 241), and the outputs listed here were selected for this hypothetical example to serve as proxies of this goal. These are thought to be key performance measures; however, any outputs the organizational units under review wish to optimize could be used in the DEA computations.

The first important DEA datum to be drawn from an analysis of these inputs and outputs is an overall score indicating the relative efficiency for each subunit. As Nyhan and Martin (1999) describe, in the DEA algorithm, those units found to be operating perfectly efficiently when compared to all of the other units under review are assigned an efficiency score of one. In the context of this paper, these units would be said to be obtaining, relatively speaking, the best sales volume, customer loyalty and complaining behavior levels, given each DMU's levels on the five dimensions of perceived service quality. Those DMUs operating less than perfectly efficiently are assigned some positive score less than one by the mathematical algorithm and are thought to have room to improve. To move up to the relative performance of its "efficient" peers, the inefficient DMU should attain either more, or at least the same, output levels with either the same, or lower, levels (respectively)

Table I Suggested inputs and outputs for data envelopment analysis of service quality in the electric service industry

Inputs[a]	Outputs[b]
Dimension 1. Personal interaction with the customer	Outcome 1. Customer loyalty
Dimension 2. Reliability of service delivery to the customer	Outcome 2. Complaint behaviour
Dimension 3. Problem solving for the customer	Outcome 3. Sales volume
Dimension 4. Policy issues with respect to the customer	
Dimension 5. Physical aspects of the relationship with the customer	

Notes: [a] Defined as the perceived levels on the five service quality dimensions; [b] Defined as desired outcomes of the service quality effort

on the dimensions of perceived service quality. In a very practical sense, such results translate into two important questions for the unit under consideration. First, "Is the DMU wasting resources, or effort, to over-develop an unnecessarily high level on one or more dimensions of perceived service quality?". Or second, is it the case that some aspect of a DMU's perceived service quality is being taken for granted and is less appreciated by its customers, such that while its perceived service quality levels are similar to the other DMUs, these perceptions are not translating into equivalent, desired organizational outcomes? The inference to be taken from this application of DEA is that, at some level, marginal increases in perceived service quality may simply not be effective from a benefit-cost perspective. It is important to note that this is true from the differing accounting perspectives of both the service provider and the customer. Inefficiencies do not benefit either.

The second output of interest from the data envelopment analysis methodology is a hypothetical, perfectly efficient, ideal "target model" for each "inefficient" organizational sub-unit, or DMU (Nyhan and Martin, 1999). It is important to note that "ideal target model" is used here in the sense of the "ideal type" analytical construct developed by Max Weber (1903-1917/1949, p. 43) and as more fully discussed by Ritzer (2000). The values for this "ideal target model" are taken from the dual of the linear program utilized in the DEA computation (see Cooper *et al.* (2000) for details of this concept). The target model offers direction for improvement as it is a linear combination of actual results attained by existing, similar, but more efficient, DMUs. Assuming such linear combinations are possible (an empirical question) the target model could, theoretically, be accomplished by the inefficient DMU. It, thus, provides practical guidance to the manager in adjusting resource allocations and/or modifying operational practices in the less efficient organizational sub-units. In the context of the present example, this target model actually highlights service quality dimensions where resources or service efforts are being inefficiently applied, based on the ratio of perceived service quality levels to realized organizational outcomes. This information serves a diagnostic purpose: It focuses attention to areas where there is potential for useful resource re-allocation, process change, or both, with respect to the identified inefficient dimension.

To clarify this notion, consider the "target model" in the context of the two-dimensional example presented earlier in Figure 1. In that illustration, the hypothetical "target" efficient DMU for DMU P is located at Q on the efficient frontier. Conceptually, the inputs and outputs of this new hypothetical DMU, Q, are a weighted average of the inputs and outputs of the efficient DMUs that define the "boundary" (in this case, DMUs R and S) making up the envelope for the inefficient DMU.

The same interpretation holds for the hypothetical DMU in a multi-dimensional case such as the one discussed here, where there are two outputs and five inputs. To demonstrate a practical application of this multi-faceted case using hypothetical data for an electric service provider, consider the following. Assume that the actual service quality survey ratings and consumer response data received from a sample of consumers for a regional organizational sub-unit, DMU1, are as displayed in the column of Table II titled "Original service quality ratings and consumer response measures".

Table II Illustrative data envelopment analysis result for hypothetical, inefficient DMU1

Inputs and outputs	Original service quality Ratings and consumer response measures[a]	Target Values based on reference set[b]	Implied Service quality reductions	Implied Percentage change dimension (absolute value)
Personal interaction	6	4.595	1.405	23.4
Reliability	5	4.781	0.219	4.4
Problem solving	5	4.781	0.219	4.4
Policy	4	3.825	0.175	4.4
Physical aspects	6	5.458	0.542	9.0
Customer loyalty	4	4.183	NA	NA
Complaining behaviour	23	28.301	NA	NA
Sales volume	1,640	1,640.000	NA	NA

Notes: [a] These hypothetical values would, in practice, be obtained by customer survey and from service provider records, respectively; [b] These values are the data produced by the DEA algorithm

In practice, these would be empirical data reporting actual customer perceptions regarding DMU1. Likewise, this column displays hypothetical levels of customer loyalty, complaining behavior, and sales volume for DMU1. Further, assuming that the data envelopment analysis algorithm indicates that DMU1 is relatively inefficient (i.e. assigns DMU1 an efficiency score of less than one), then a theoretical "target model" of ideal, efficient levels for inputs and outputs for DMU1 can be derived from the dual of the DEA application as noted above. This "target model" is based on the actual operations of the several DMUs in the efficient reference set. Given a DEA efficiency score of less than one for DMU1, Table II presents the ideal "target model" for DMU1 in the column titled "Target values based on reference set". The efficiency score assigned to DMU1 suggests that other DMUs in the efficient reference set are getting more "bang for the buck" with respect to the utility of the perceived levels of service quality. Either they are obtaining better organizational outcomes than DMU1 even though their perceived levels of service quality are similar to that of DMU1, or they are obtaining similar outcomes to those observed by DMU1, but have lower perceived service quality levels for some combination of the five dimensions of service quality. Whichever the case, the implication is that in order for DMU1 to move to the efficiency frontier, some managerial attention to the linkage between the five dimensions perceived of service quality and resulting organizational outcomes is required. The target model identifies problem areas for consideration by management. The values listed in the last two columns of Table II depict the suggested excesses for DMU1 as compared to others in the data set.

However, the following question is noteworthy: Does this "target model" suggest that perceived service quality should be reduced by DMU1? After all, to increase efficiency in the traditional sense of managerial or engineering efficiency, with other things being equal, inputs should be decreased! This, however, is counter-intuitive. A traditional "on its face" interpretation of the typical "target model" and its prescribed adjustments would, in fact, suggest managers work to directly reduce some combination of the inputs by the amount of prescribed change while maintaining the level of outputs. For instance, in this example, it might be suggested managers of DMU1 should work to reduce perceived service quality levels among its customers for the dimension "Personal interaction in service provision" by 23 per cent to move to the efficiency frontier. Had this input represented an actual expenditure or some other specific outlay of resources, this might make sense. Here, however, it represents a level of perceived service quality which is being compared to a theoretical construct, or "ideal type", based on the results obtained by others.

Obviously, an organization would not wish to purposely reduce perceived service quality levels among its customers ... the received presumption is that organizations benefit from high levels of perceived service quality. Instead,

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

the authors argue the adjustments prescribed here serve more usefully as ordinal indicators of inefficiencies ripe for change. Overall, someone is getting more "bang for the buck" in terms of efficient utilization of perceived service quality. Dimensions are highlighted where other DMUs have been able to get more return and, thus, DMU1 should examine its operating procedures in these identified service quality dimensional areas to identify possible sources of operating inefficiency or ineffectiveness. The magnitudes of the changes prescribed by the "target model" simply serve to rank the dimensions in terms of those areas most likely to produce efficiency gains. By focusing on the most important areas, the organization is more likely to efficiently and effectively provide a service that more adequately meets customers' needs and desires while, at the same time, maximizing the organization's goals. The important issue here is improvement in efficiency and effectiveness measured in terms the ratio of resources consumed and important organizational goals accomplished, as these relate to the five dimensions of perceived service quality. The issue is not attainment of the prescribed level of perceived service quality in the target model, itself.

From this perspective, the results displayed in the hypothetical Table II suggest the greatest efficiency gains are possible in the areas of "Personal interaction in service provision" and "Physical aspects of service provision" (the algorithm implies changes of 23 per cent and 9 per cent, respectively, for these dimensions). These are substantially greater proportional adjustments than the 4 per cent adjustments shown in Table II for the other service quality dimensions. Had the other dimensions been identified as the focal point for attention, then the suggestion would be that the inefficient DMU re-examine its efforts in those areas.

In this case, however, focus should initially be on "Personal interaction in service provision" and "Physical aspects of service provision" to find sources of inefficiency. Perhaps fewer resources should be devoted to maintaining long office hours or it is possible voice mail would be more appropriate than providing 24-hour personal telephone interaction, either for reporting service problems or for customers who ask frequently-asked service-related questions. Are the results of these interactions with customers actually "overkill"? There is a narrow margin between too little and too much emphasis on service quality, but these are the types of hard questions raised by the application of data envelopment analysis to reported levels on service quality dimensions. The process recognizes the presence of diminishing returns even in the area of service quality based on the results of others. Such deeper analysis of service quality as that provided by DEA suggests that one can actually have too much of what is generally accepted on its face as "a good thing".

There are other ways to view the information supplied by the ideal target model. For example, perhaps the inefficient DMU should realize that its efforts to meet environmental demands of customers, laudable as they may be, are simply not appreciated by the customers in the same manner as in the case of the more efficient DMUs in the efficient reference set. Remember, this analysis is based on consumer perception, and as such may call for a qualitative review of DMUs in the efficient reference set. Improvement may not simply lie in the direct reallocation of resources away from environmental concerns; rather, it may be found that this is a much more complex linkage; for example, other DMUs may have a more effective way of publicizing their environmental efforts. Adopting such methods would move the inefficient DMU in the direction of the efficient frontier, allowing them to increase the "bang for the buck".

The hypothetical example in Table II demonstrates the diagnostic potential for data envelopment analysis to provide guidance regarding needed marginal comparisons for directing attention toward resource re-allocation or operational changes to effect efficiency with respect to the targeted levels of the specified dimensions of perceived service quality. With this guidance, on-the-scene managers should be able to "brainstorm" many options for improvement since, importantly, in practice, the guidance offered by DEA is based on actual efficiency levels attained by comparative organizations or sub-units. Simply put, data envelopment analysis can provide decision makers with very useful preliminary, diagnostic information by focusing attention on

Managing Service Quality
Volume 14 · Number 1 · 2004 · 75-89

service quality dimensions where others are obtaining better results.

Conclusion

The purpose of this paper is to introduce professional managers and interested others to an innovative application of data envelopment analysis useful for the diagnosis and management of service quality. It is suggested that DEA can be used by practitioners to manage service quality more effectively than other, more traditional methods. Application of the technique to specified dimensions of consumer service quality data reveals otherwise unavailable information and provides the analytical linkage between specified dimensions of perceived service quality and the ultimate goals of service providers and service consumers. Not only will DEA allow the practicing manager to systematically compare service quality performance for various sub-units across an organization (or, across similar organizations in a selected sector), the technique provides a hypothetical, target model for an ideal combination of performance levels for the various dimensions of service quality based on actual practices of similar others which managers can use to improve operations. Because of these capacities, data envelopment analysis is a methodology that managers should consider.

There are, however, limitations to the present work. For example, we have used the retail electric energy market as a frame of reference for our discussion. And, based on recent comments by Lindenberg, regarding applied business research, we feel investigation of this innovative application is very appropriate to the current trends in retail markets for electric energy. In "Electric cooperatives in a deregulated market", Lindenberg says:

> Today's needs include new technical, business, and marketing skills necessary to successfully manage a competitive enterprise ... this overarching challenge hovers over the entire electric utility industry. [Electric cooperatives] are equipping themselves with the skills, knowledge, and resources to become an even larger player in the restructured utility market of the 21st century (Lindenberg, 2000, pp. 42, 44).

We feel these practitioner "skills, knowledge, and resources" are comprised of analytical techniques such as the one discussed here. However, Lindenburg's comments seem appropriate for all retail marketing activities, not just those associated with electricity. We believe the DEA application discussed here can be generalized to organizational settings beyond electric energy retailers, both in the public sector and the private sector. Thus, to overcome this limitation, we encourage real time, empirical research and experimental applications by professional managers, as well as scholars, to develop this notion. This will entail study of the data envelopment analysis procedure itself, collection of service quality data in different marketing scenarios and adaptation of the procedure as appropriate to those settings. In addition to this, one continuing requirement is the correct specification of dimensions of service quality for different organizational settings. As discussed above, this has proven to be a difficult task for researchers and practitioners alike, and the conundrum provides an interesting direction for future research.

Concurrent with this proposed applied research process, theoretical improvements, development of alternative models and fine-tuning of the data envelopment analytical procedure, itself, continue to emerge in the management literature. Fortunately, easily accessible software packages are available to practitioners that make such analysis reasonably straightforward. Some packages can be down-loaded for management experimentation. One particularly useful demonstration package is Frontier Analyst®, a product of BANXIA® Software Ltd (which can be found at www.banxia.com/famain.html). An advanced professional model is available for purchase at a moderate price from BANXIA® for those who wish to use the package. The demo package features a downloadable manual describing the technique, the Frontier Analyst® software and its application (Frontier Analyst®, 2003). Of course, other DEA software packages are to be found on the Web also, and we encourage interested practitioners to investigate these.

Practicing managers may also be interested in the definitive review of the current state of the art in DEA application. In our opinion, this can

be found in *Data Envelopment Analysis: Theory, Methodology and Applications* (Charnes *et al.*, Eds, 1994). This work provides an excellent overview of currently emerging DEA models for practitioners, includes a discussion of limitations of the DEA methodology, and reports an extensive bibliography of recent DEA studies. The book is accessible to the marketing manager with a minimal background in operations research technique.

We encourage professional managers to engage data envelopment analysis as an avenue for the expansion of:

> ... skills, knowledge and resources [required] to become even larger players in the 21st century (Lindenberg, 2000, p. 44).

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