INDUSTRIAL FOREST PRODUCT QUALITY: AN EMPIRICAL TEST OF GARVIN'S EIGHT QUALITY DIMENSIONS

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ABSTRACT

A national sample of purchasing executives was asked to rate 26 product and dealer/manufacturer attributes on the basis of their importance in assessing office furniture quality. Attributes were selected a priori to represent eight quality dimensions—performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. Results of confirmatory factor analysis failed to support the eight dimensional structure. However, subsequent exploratory factor analysis utilizing raw and transformed rating scores supported the existence of most dimensions. Results also suggest the combining of performance and feature dimensions, adding an economic (price/value) dimension, and the existence of a strong association between service and perception of overall quality.

Keywords: Office furniture, quality, service, price.

Few in business today have not wrestled with the strategic implications of product quality. Whether in goods or services, developing an effective quality strategy is one of the most important challenges facing top management today (Cravens et al. 1988; Ross and Shetty 1985). It is difficult even to discuss industrial marketing without focusing on the concept of product quality (White and Cundiff 1978). From a national perspective, poor quality is blamed for lagging U.S. foreign trade and growing international competition. From the perspective of the firm, good product quality is associated with improved return on investment, higher profits, increased market share, and lower costs (Garvin 1988, 1984a, b; Jacobson and Aaker 1987; Luchs 1986; Phillips et al. 1983; Shetty 1987). Quality has become the new "mantra" for corporate management (Bacon 1988) and has replaced price as the key determinant of market share and profit margins (Ross and Shetty 1985).

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WHAT IS QUALITY?

While most authors contend that product quality is complex and hard to define, they tend to agree that quality is based on product attributes that are largely defined by the customer (Garvin 1984a; Shetty 1987; Takeuchi and Quelch 1983). Garvin advocates a deeper understanding of the customers' perspective as a necessary first step in defining product quality. According to Garvin (1984a), "Quality is not a single recognizable characteristic; rather it is multifaceted and appears in many different forms." Consequently, he proposed eight facets or dimensions of product quality.

The first dimension, *performance,* relates to the "primary operating characteristics" of the product. For example, in a sports car speed would be a performance attribute and, therefore, one of the dimensions used to assess the quality of the sports car.

Second, *features* are secondary characteristics of a product or the "bells and whistles" (Garvin 1987). Features may be highly visible but not necessarily primary or even important characteristics of the product. A sun roof might be a feature that is used by some customers to assess quality, but it is not instrumental in making performance judgments. Moreover, the distinction between performance and features is ambiguous. As Garvin notes, in many cases the distinction between primary performance characteristics and secondary features is one of relative importance to a particular customer or user group.

Third, *reliability* indicates the degree to which a product can be counted on to perform as expected and for which the odds of failure are small. Reliability includes such things as mean time to first failure, mean time between failures, and failure rate per unit of time (Garvin 1987).

Fourth, *conformance* relates to the degree a product's design and operating characteristics match preestablished standards. Does the product conform to standards or do what it is supposed to do? Or, are there frequent disappointments? Examples of conformance failures include lost mail, delays in airline departures, incorrect bank statements, misspelled labels, and shoddy construction (Garvin 1987).

Durability is the fifth dimension and reflects the economic or physical life of the product. It also encompasses concerns over a product's availability: that is, if the product breaks down, can it be brought back into service quickly? Thus, whether or not a product is designed so that repairs can be made simply, and without specialized personnel, should have an impact on perceptions of durability. Durability is also affected by repair costs, the cost of downtime, the relative prices of replacement products, and other economic factors.

The sixth dimension, *serviceability,* is concerned with the ease with which the product can be serviced, the time required for service, the quality of the repair service, and the competence and professionalism of the service personnel.

Aesthetics is seventh and refers to attributes that appeal to the senses such as looks, feel, taste, smell, and so on. Aesthetics also recognizes superiority in fit and finish. This dimension is probably the most subjectively evaluated of the eight.

Finally, dimension number eight is *perceived quality.* The perceived quality of a product is concerned more with images originating from advertising, brand identification, and previous experiences than with the actual product characteristics. A product's history and affiliation with superior quality through its market positioning affect its perceived quality. As might be expected, perceived quality is similar to aesthetics in terms of being a very subjective dimension. Both, however, help shape first impressions of product quality and subsequently affect buyer behavior.

Garvin's dimensions of quality are reasonable and would appear to be useful for industrial forest products. However, to date no research has been uncovered that supports the validity of this quality definition. The major goal of this manuscript is to report the results of a research project that tested Garvin's theoretical notions. Each of the eight dimensions

was operationalized as sets of attributes chosen to fit Garvin's descriptions. Industrial purchasers were surveyed and the data were factor analyzed either to accept or to reject Garvin's model. The details of this study and the results follow.

METHODOLOGY

To test Garvin's notions, decisions had to be made about the selection of the industrial forest product, the relevant attributes, the sample, and who the primary respondents should be.

Product selection

Office furniture was selected as the product category for this research. Although Garvin's theoretical notions were being tested in this research project, a major concern was the adaptability of his quality dimensions to an array of industrial forest products.

Moriarty and Reibstein (1986), in a study of industrial product-markets, gave four criteria they used to maximize the generalizability of their results.

- The product exists in a competitive market.
- The purchase of the product is relatively important to the operation of the acquiring company.
- In the buying companies, the purchase decision process must potentially involve a number of functional areas and levels of management.
- The product has a broad market and is purchased by different types and sizes of businesses.

It is our belief that these four criteria fit office furniture very well and indicate that the results of the study using office furniture should be generalizable to other products.

Attribute selection

The choice of office furniture as the product category helped solve the second problem, selecting product attributes. A number of researchers have identified attributes that organizational purchasers use to select and purchase office furniture (Anderson 1976, 1973; Anon. 1985; Crawford et al. 1983). In addition, articles in the general marketing literature provided other more generic attributes that helped fill the voids in Garvin's attribute structure (Alpert 1971; Heeler et al. 1979; Lehmann and O'Shaughnessy 1974; McAleer 1974; Moriarty and Reibstein 1986; Myers and Alpert 1968; Ozanne and Churchill 1971). The selected attributes and the dimensions they were expected to measure are provided in Table 1.

The two most difficult dimensions to select attributes for were performance and secondary features. Not only does Garvin indicate the difficulties involved in distinguishing between the two, but attributes used to define these dimensions are closely related to individual purchaser preferences. Attributes selected to represent these dimensions were chosen on the basis of their relation to the individual purchaser. For instance, the ability to enhance user status, acoustic properties, worker productivity, and the multifunctional nature of the product all relate to the individual purchaser or user.

Garvin (1984b) did not explicitly include price or value in his dimensions, stating that price is a correlate of quality. However, the price/quality relationship has been given so much attention in the marketing literature (Monroe 1973; Monroe and Dodds 1988) that price and value were included under the feature dimension.

Attribute selections were constrained so that each of Garvin's eight quality dimensions were represented by at least three attributes to meet the requirements of attribute structure analysis (Peter 1979). The hypothesis tested in this research was that the twenty-six product and dealer/manufacturer attributes best represented the eight dimensional or factor structure illustrated in Table 1.

Choice of survey respondent

Industrial purchasing is characterized by multiperson involvement in the purchase decision process (Crow and Lindquist 1985; Ghingold 1985; Sheth 1973; Spekman and

TABLE 1. *Confirmatory analysis of Garvin's eight quality dimensions.*

Quality dimension	Cronbach's alpha
1. Performance	0.5449
Effect on worker productivity	
Ability to enhance status of the user	
Multifunctionality of product	
2. Features	0.5578
Availability of engineering/design staff	
Acoustics	
Price	
Value	
3. Reliability	0.7915
Reliability	
Infrequent failure	
Absence of failure in first five years	
4. Conformance	0.8899
Ability to meet specifications	
Ability to deliver on schedule	
Ability to provide defect free products	
5. Durability	0.8812
Service life	
Structural integrity	
Resistance to wear	
6. Serviceability	0.7810
Easy to maintain	
Dependable, competent installation	
Speed of repair service	
7. Aesthetics	0.7777
Aesthetics	
Compatibility with existing decor	
Compatibility with existing furniture	
Variety of styles and colors	
8. Perceived quality	0.6361
Brand name	
Reputation	
Previous experience	
Chi-square (df = 279)	936.3 ($P < 0.0001$)
Goodness-of-fit index	0.781
Adjusted goodness-of-fit	0.725
Root mean square residual	0.268

Stern 1979). Notwithstanding the generally accepted involvement of others, Lehmann and O'Shaughnessy (1974) claim that the purchasing agent is still a key figure ". . . whose evaluation of suppliers and products is likely to influence—if not determine—the company's final choice." Crow and Lindquist (1985) found that for both modified rebuy and new purchase decisions, organizational buyers perceived their influence in the eventual purchase to be the "dominant factor." Patton et al. (1986) concluded that individual buyers make most of the decisions in two-thirds of the modified rebuys.

Consequently, although others are included in office furniture purchases, it was felt that the purchasing executive's role was still of prime importance. In addition, several other factors led to the targeting of purchasing executives including: (1) their involvement in the

purchase process for office furniture is assured regardless of how many other individuals may be involved; (2) only purchasing executives have the experience to adequately rate dealer/manufacturer services; and (3) purchasing executives can be readily identified within the organization.

The sampling frame

A total of 606 purchasing executives were mailed a four-page questionnaire. Names and addresses were purchased from a commercial mailing list containing over 90,000 entries for purchasing executives throughout the United States. The following constraints were imposed on the selection of individual purchasing executives: (1) only one person was chosen per firm so that respondents represented a broad array of businesses; (2) firms represented by the purchasing executives had to employ at least 100 persons; and (3) an equal number of manufacturing and nonmanufacturing firms had to be represented. Within the constrained listing, individuals were randomly selected.

Survey response

After two mailings of the questionnaire and the mailing of a separate follow-up letter in between, 139 responses were received. Allowing for "no forwarding address" returns and nonuseable returns (Dillman 1978) this represented a response rate of nearly 26 percent. Patton et al. (1986) reported a response of 482 out of 4,000 or an unadjusted rate of 12.5 percent in a similar survey. Thus, response to the survey was considered acceptable.

Several questions of a descriptive nature were included on the questionnaire to check nonresponse bias by comparing early and late returns. If differences were detected, they would have indicated possible nonresponse bias, as late respondents tend to be more like nonrespondents (Fowler 1984).

No significant differences were found to exist between early and late respondents on the basis of years of experience, education, and firm sales. However, early respondents bought significantly more furniture in the previous year and represented companies that employed more people than did late respondents. This indicates that survey respondents may have purchased more furniture and may have represented firms with larger employment than nonrespondents, but that does not diminish the utility of the attribute ratings received. In fact, if anything, it suggests that the respondents had a greater involvement in office furniture purchasing and a better knowledge base from which to rate attributes than did the general population of purchasing executives.

Each respondent was asked to rate attributes for each of two types of office furniture (conventional and panel and modular systems) resulting in 278 observations. However, because confirmatory factor analysis calls for listwise deletion of missing values, 29 observations had to be dropped. Consequently, the analyses were run on 249 observations.

ANALYSIS

LISREL 7 (Joreskog and Sorbom 1989) was used to perform a confirmatory factor analysis on Garvin's eight quality dimensions. Principal components factor analysis was used to perform exploratory factor analyses.

Confirmatory factor analysis

The hypothesis that guided this research was that the quality of an industrial forest product can be defined by Garvin's eight quality dimensions. Technically, if Garvin's definition of quality is to be accepted, the eight factor structure should accurately reproduce the covariance matrix (i.e., the eight dimensional model should fit the data). One indicator of the model's fit, the chi-square test statistic, provided strong evidence against Garvin's eight dimensional structure of quality [$\chi^2(df = 279) = 936.6$]. However, Bagozzi and Yi (1988) point to the sensitivity of the chi-square statistic to large sample sizes (i.e., chi-square increases proportionately to sample size) and suggest how it is possible to have conflicting indicators. For relatively large sample sizes, the chi-square statistic will be large, resulting in rejecting the null hypothesis. Therefore, other measures need to be evaluated.

Two additional measures of fit are the good-

ness-of-fit and adjusted goodness-of-fit. These measures indicate the amount of variance and covariance jointly accounted for by the model and range in value from 0.0 to 1.0. Bagozzi and Yi (1988) suggest a value of 0.9 for the adjusted goodness-of-fit index to be the lower bound for indicating that the model fits the data. Thus, the calculated value of 0.725 is considerably below the cut-off and provides further indication that Garvin's model does not adequately fit the data.

The root mean square residual is another measure that is used to evaluate model fit. Roughly, this index indicates error variance in the model—the less the better. A value of more than 0.1 indicates problems with the model or lack of congruence between the model and the data (Bagozzi and Yi 1988). The reported root mean square residual (rmsr = 0.268) provides still additional evidence that the model doesn't fit the data. At least for the product category and attribute structure used in this study, Garvin's eight dimensions were not supported.

Internal consistency

The internal consistencies of the original quality dimensions were analyzed using Cronbach's alpha to see if a lack of internal consistency (reliability) could have accounted for the findings. The cut-off used to determine if a dimension was internally consistent was 0.60 (Bagozzi and Yi 1988; Peter 1979). Of the eight dimensions analyzed, Performance (alpha = 0.55) and Features (alpha = 0.56) failed to achieve the 0.60 consistency level (Table 1). Consequently, it was decided to use exploratory factor analysis in an attempt to discover an alternative attribute structure.

Exploratory factor analysis

In exploratory factor analysis, unlike confirmatory factor analysis, variables that measure each common factor are not identified prior to estimation. Rather, variables or attributes are permitted to load on all factors, and only after loadings have been estimated are judgments made as to which variables are measuring what factors (Dillon and Goldstein 1984).

Variables with loadings (correlations) of less than 50 were dropped. This Dillon and Goldstein (1984, p. 70) refer to as the test of "practical significance." Stevens (1986, p. 353) also cites an example in which attention is limited to loadings greater than 50, despite the fact that loadings as low as 34 are statistically significant. Earlier (p. 344) Stevens states: "Once one is confident that the loadings being used for interpretation are significant . . . , then the question becomes which loadings are large enough to be practically significant."

Principal components factor analysis with varimax rotation resulted in a five factor solution (Table 2). Factor retention was based on the SAS default option, which calls for retaining only those components whose eigenvalues are greater than 1. This criterion, offered by Kaiser in 1960, is according to Stevens (1986, p. 341), probably the most widely used in determining the number of factors to be retained.

Two attributes failed to achieve a factor loading of 50 on any factor. These were variety of styles and colors (an aesthetic dimension attribute) and easy to maintain (a serviceability dimension attribute). Attributes chosen to represent three of Garvin's dimensions—conformance, durability and reliability—all combined into one 11-attribute factor that explained 26.5 percent of the variance in the attribute set. This model did generate a service/perceived quality dimension, a performance/feature dimension, and an aesthetic dimension. However, recognizing that response style bias (Schaninger and Buss 1986) can affect response to interval scaled inquiries, several data transformations were investigated to see if they might provide additional delineation of the conformance, durability and reliability dimensions.

Data transformation

Schaninger and Buss (1986) suggest that differences in respondent tendencies, referred to as response-style bias, may introduce unwanted error into rating scale scores. Wilkie and Pessemier (1973) referred to this as "idiosyncratic" response bias. Response bias is

TABLE 2. *Exploratory analysis of Garvin's quality dimensions.*

	Quality dimension	Loadings (×100)	Percent of variance explained	Cronbach's alpha
1.			26.5	0.9364
	Structural integrity (5)[a]	83		
	Ability to deliver on schedule (4)	79		
	Ability to provide defect free products (4)	79		
	Ability to meet specifications (4)	78		
	Resistance to wear (5)	72		
	Infrequent failure (3)	69		
	Reliability (3)	68		
	Value (2)	66		
	Service life (5)	65		
	Absence of failure in first five years (3)	61		
	Aesthetics (7)	55		
2.			14.7	0.8570
	Availability of engineering/design staff (2)	73		
	Reputation (8)	67		
	Dependable, competent installation (6)	64		
	Speed of repair service (6)	59		
	Previous experience (8)	55		
3.			9.5	0.6722
	Acoustics (2)	73		
	Multifunctionality of product (1)	67		
	Effect on worker productivity (1)	62		
	Ability to enhance status of the user (1)	52		
4.			9.3	0.6107
	Brand name (8)	72		
	Compatibility with existing furniture (7)	62		
	Compatibility with existing decor (7)	59		
5.			7.5	N.A.
	Price (2)	77		
			67.5	
	Attributes with loadings of < |50|			
	Variety of styles and colors (7)			
	Easy to maintain (6)			

[a] Number in parentheses represents a priori quality dimension assignment in Table 1.

manifest in two ways. First, respondents may differ in terms of their preference for responding to certain points on the rating scale. Some may tend to cluster responses at the top end, whereas others may exhibit preferences for the bottom or the middle of the scale. The second manifestation is that some respondents may confine ratings to a relatively narrow range within the scale, whereas others may make use of the entire range.

Three types of data adjustment alternatives are row-centering, normalization, and standardization (Schaninger and Buss 1986). Both row-centering and normalization remove central tendency or location bias. The standardization process eliminates both central tendency and variance differences among respondents. Which should be used, if any, is often situationally dependent. Schaninger and Buss (1986) found in their situation that standardization clearly produced a more meaningful and appropriate basis for segmentation than either row centering or normalization. Moriarty and Reibstein (1986), on the other hand, used a row-centering procedure on determinance scores to investigate benefit segmentation in industrial markets.

Row-centering.—Overall, the row-centering

TABLE 3. *Exploratory analysis of row-centered quality ratings.*

	Quality dimension	Loadings (×100)	Percent of variance explained	Cronbach's alpha
1.			10.5	0.8158
	Ability to meet specifications (4)[a]	83		
	Ability to deliver on schedule (4)	74		
	Structural integrity (5)[a]	52		
	Ability to provide defect free products (4)	50		
	Multifunctionality of product (1)	−64		
2.			7.6	0.5702
	Aesthetics (7)	80		
	Ability to enhance status of the user (1)	55		
	Reputation (8)	−63		
3.			7.3	0.6243
	Price (2)	69		
	Value (2)	50		
4.			7.0	0.7793
	Compatibility with existing decor (7)	80		
	Compatibility with existing furniture (7)	76		
5.			7.0	0.8566
	Service life (5)	76		
	Resistance to wear (5)	68		
6.			6.8	0.7532
	Effect on worker productivity (1)	84		
	Reliability (3)	59		
7.			6.6	0.7986
	Absence of failure in first five years (3)	78		
	Infrequent failure (3)	76		
8.			5.8	0.7022
	Dependable, competent installation (6)	75		
	Variety of styles and colors (7)	63		
9.			5.4	N.A.
	Brand name (8)	77		
10.			5.1	N.A.
	Easy to maintain (6)	85		
			69.1	
	Attributes with loadings of $< \|50\|$			
	Previous experience (8)			
	Speed of repair service (8)			
	Acoustics (2)			
	Availability of engineering/design staff (2)			

[a] Number in parentheses represents a priori quality dimension assignment in Table 1.

model provided marginal improvement in the explanatory power of the model (i.e., increase from 67.5 to 69.1 percent of variance explained). Row-centering did achieve a break-up of the 11 attribute factor into the dimensions of conformance, durability, and reliability (Table 3). In addition, the row-centered model resulted in a more clearly defined aesthetic dimension by excluding brand name. It also resulted in a single factor representing price and value. Exploratory factor analysis using standardized transformations of the original raw scores provided no additional insights.

Garvin's product quality model revised

Based on insights gained from the exploratory analysis of Garvin's model, it was revised as can be seen in Table 4. Seven factors were

TABLE 4. *Confirmation analysis of revised Garvin dimensions.*

Quality dimension	Cronbach's alpha
1. Performance/features	0.6722
Acoustics (2)[a]	
Multifunctionality of product (1)	
Effect on worker productivity (1)	
Ability to enhance status of the user (1)	
2. Reliability	0.7986
Absence of failure in first five years (3)	
Infrequent failure (3)	
3. Conformance	0.8899
Ability to meet specifications (4)	
Ability to deliver on schedule (4)	
Ability to provide defect free products (4)	
4. Durability	0.8812
Structural integrity (5)	
Service life (5)	
Resistance to wear (5)	
5. Service/perceived quality	0.8389
Dependable, competent installation (6)	
Reputation (8)	
Speed of repair service (6)	
Previous experience (8)	
6. Aesthetics	0.7793
Compatibility with existing decor (7)	
Compatibility with existing furniture (7)	
7. Economic	0.6243
Price (2)	
Value (2)	
Chi-square (df = 156)	353.5 ($P < 0.001$)
Goodness-of-fit index	0.878
Adjusted goodness-of-fit	0.836
Root mean square residual	0.087

[a] Number in parentheses represents a priori quality dimension assignment from Table 1.

specified rather than Garvin's eight, but, in general, the revised model is not substantively different from the original model. Six attributes were dropped because they showed no consistent association with any factor or because their factor loadings were too low and/or coefficient alpha increased for the particular factor when they were dropped.

LISREL was used to evaluate the fit of the revised model. All statistical measures of model fit were improved over those derived from the original 26 attribute construct. The chi-square value went from 936.3 to 353.5. Also, the goodness-of-fit index increased to 0.878, the adjusted goodness-of-fit index to 0.836, and the residual mean square dropped well below the requisite 0.1. Finally, all factors exhibited coefficient alphas above 0.6 indicating that each of the seven quality dimensions were internally consistent and reasonably reliable.

DISCUSSION

For a company or industry to develop an effective quality strategy, it must first define quality from a customer perspective. Garvin proposed the existence of eight dimensions to provide a framework for formulating quality initiatives. These dimensions are: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. Despite this study's initial failure to confirm empirically Garvin's eight

quality dimensions using confirmatory factor analysis, subsequent investigation using exploratory factor analysis and transformed attribute ratings provided support for most, if not all, of Garvin's eight quality dimensions.

Of particular interest is that the difficulty Garvin expressed over separation of performance and secondary feature attributes seemed to exist among buyers of office furniture. Further, while Garvin's eight quality dimensions failed to explicitly include price and/or value, these two attributes formed a separate dimension. Consequently, in seeking to operationalize quality dimensions, it seems best to eliminate making distinctions between performance and feature attributes and include explicit recognition of an economic (price/value) dimension.

One other observation of note from this study is the close association of perceived quality and service. The importance of providing quality service is widely discussed in the more recent quality literature. Those investigating the market for office furniture have also discussed the growing need for dealers and manufacturers to provide services—particularly those selling systems products. Sonnenberg (1989) cites a company survey of nearly 2,400 customers in which the number one reason for switching to the competition was poor service.

What this investigation found, however, is that quality assessments derived from services offered are not isolated to the service function. In fact, the services offered and the quality of those services significantly impact the perceived quality of the entire company and its product(s). Consequently, a company that fails to provide services or whose service quality is not up to par may negatively affect the quality perceptions of its physical products as well (Kasper and Lemmink 1989). Thus, actions taken to improve product quality may not affect overall perceptions. Companies may well be perceived through people and through the services they provide as much or more than through the actual physical product.

Three modifications of Garvin's quality dimensions are suggested. First, the performance and the feature dimension may well be combined as it may be impractical, if not impossible, to divide attributes along these lines. Garvin is correct in his assertion that the distinction many times lies with the individual. Second, a separate dimension should be included for price and value. The current eight dimension construct offered by Garvin does not explicitly provide for recognition of the price quality relationship. Third, the perceptions of quality are related as much to services as they are to reputation and previous experience.

CONCLUSIONS

Quality of industrial forest products can be viewed as being multifaceted. Through this investigation, Garvin's theoretical dimensions of quality were largely confirmed. At least in this study, quality can be operationalized using seven dimensions; Performance/Features, Reliability, Conformance, Durability, Service/Perceived Quality, Aesthetics, and Economics. Especially noteworthy for industrial marketing managers was the strong association between service and perceived quality. Industrial marketing managers can use these dimensions as a framework to understand better how their customers view quality. Marketing strategy formulation should address these dimensions and pay particular attention to those dimensions critical for a given customer segment.

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