QUALITY MANAGEMENT INFLUENCES ON LOGISTICS PERFORMANCE

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Abstract—The importance of quality management practices in the achievement of operational results and customer satisfaction in logistics has been asserted in many studies. However, though widely adopted, quality management does not have a uniformly accepted framework as a basis for assessment of improvement efforts. This study develops quality management constructs and a causal model based on the criteria utilized in the Malcolm Baldrige National Quality Award. Casual relationships between quality management factors and logistics outcomes, specifically logistics operational performance and customer service, are established. Implications of the findings for management are discussed. © 1998 Elsevier Science Ltd. All rights reserved

Keywords: Quality management, logistics performances, Baldrige Award, customer satisfaction.

1. INTRODUCTION

Quality management programs have been implemented globally, across manufacturing and service industries, and in profit and non-profit sectors. Leadership and team building have been identified as key factors in quality management. From a quality management perspective, the emphasis of leadership is on the communication of values and the articulation of a vision (Bennis and Nanus, 1985). These activities are similar to those prescribed by transformational leadership theory (Bass, 1985; Burns, 1978; Kuhnert and Lewis, 1987). Thus, leadership is viewed as a behavior that modifies the motivation or competencies of others (Bass, 1990). The use of teams has been the primary mechanism to implement the necessary workforce changes to achieve organizational goals (Coleman, 1996; Elmuti, 1996).

Although widely adopted, quality management does not have a uniformly accepted framework as a basis for assessment of improvement efforts. The most common guidelines are Deming’s (1982) 14 points, Juran’s (1989) planning, control and improvement activities, and Crosby’s (1979) hierarchy of 14 quality steps. The Malcolm Baldrige National Quality Award, created by the United States government in 1987, has operationalized many of the quality concepts from these pioneers in quality management into seven categories to assess quality.

The similar, but not identical, views of quality management by Deming, Juran, Crosby and the Baldrige criteria have motivated efforts to identify the appropriate set of critical quality management constructs that could be quantified by measurement scales (Ahire et al., 1996; Black and Porter, 1996; Flynn et al., 1994; Powell, 1995; Saraph et al., 1989). Unfortunately, each study has provided a somewhat different set of empirically derived factors. However, factors reflecting committed leadership, human resource activities, supplier management, data and measurement reporting, and customer satisfaction were present in each study. These derived factors are generally consistent with the Baldrige criteria. Furthermore, the Deming, Juran, Crosby and Baldrige
perspectives each imply quality management should be viewed as a causal process. The implications of Deming’s 14 points have been formulated into a set of constructs (Anderson et al., 1994) and tested as a path analytic model (Anderson et al., 1995).

The importance of quality management practices in the achievement of operational results and customer satisfaction in logistics has been asserted by a number of scholars in the logistics academic journals (Holcomb, 1994; Langley and Holcomb, 1992; Mentzer, 1993; Read and Miller, 1991). Two of the leading studies on logistics quality management were published by the Council of Logistics Management (CLM). Each identifies practices and processes similar to those referred to above and suggest that they affect logistics performance and customer satisfaction. However, neither study attempted to establish a cause–effect relationship between quality management efforts and logistics outcomes.

The primary objective of this article is to determine whether there are causal relationships between quality management factors and logistics outcomes, specifically logistics operational performance and customer service. Toward this end, quality management constructs and a causal model based on the Baldrige criteria are developed. The Baldrige criteria were selected over constructs based on Deming’s 14 points due to the increasing acceptance of the criteria as the standard of excellence. Further, to our knowledge, no causal model based on the Baldrige criteria has been postulated or tested. Thus, this research contributes to extending the theory of quality management using industry-accepted factors. The remainder of the article is organized as follows: first, a brief review of the Baldrige criteria and the CLM sponsored quality studies is provided; next, quality management constructs and causal hypotheses are delineated; the research design, analysis and findings are then presented; and, finally, conclusions and implications are discussed.

2. THE BALDRIGE CRITERIA AND CLM QUALITY STUDIES

The Baldrige Award utilizes seven categories as the basis for quality assessment. The National Institute of Standards and Technology (NIST) is the non-regulatory agency charged with the managerial responsibilities of the award. The specific evaluations within each category have changed over the years, with the latest revision occurring in 1998. The NIST maintains a site on the World Wide Web (i.e. www.quality.nist.gov) that provides the latest information concerning the award. The general descriptions of the seven categories, given at this site, are summarized below.

1. **Leadership.** The company’s leadership system, values, expectations, and public responsibilities.
2. **Information and analysis.** The effectiveness of information collection and analysis to support customer-driven performance.
3. **Strategic planning.** The effectiveness of strategic and business planning and deployment of plans, with a strong focus on customer and operational performance requirements.
4. **Human resource focus.** The success of efforts to realize the full potential of the work force to create a high performance organization.
5. **Process management.** The effectiveness of systems and processes for assuring the quality of products and services.
6. **Business results.** Performance results, trends and comparison to competitors in key business areas—customer satisfaction, financial and marketplace, human resources, supplier and partners and operations.
7. **Customer and market focus.** How the company determines customer and market requirements and expectations, enhances relationships with customers and determines their satisfaction.

It should be noted that the Baldrige category criteria are not mutually exclusive. For example, a competitive comparison element appears under three categories: Information and Analysis, Process Management and Customer and Market Focus.

The use of the Baldrige criteria is supported by the results of two research projects sponsored by the CLM as each identified several factors included in the Baldrige criteria as important to improving the logistics process. A comprehensive study of the logistics improvement process was conducted by A.T. Kearney for the CLM in 1991. The research team surveyed more than 400 U.S.
based companies and conducted 57 interviews with leading companies in quality and productivity improvement. The objective of the study report was to provide guidance on how to begin and sustain a quality and productivity-improvement process (Byrne and Markham, 1991). Methods and characteristics of firms perceived to be successful in the area of logistics customer value and satisfaction were identified and used as the foundation for recommendations and suggestions on quality improvement.

The A.T. Kearney study report was organized around four major categories of characteristics shared by successful firms in the creation of customer value. Along with business strategy (i.e. competitive positioning, leadership, mission and goals), these categories comprised what the authors referred to as “The Process of Creating Customer Value”. The four categories were: customer-driven service strategy (e.g. needs/requirements, expectations, service strategy), senior management commitment (e.g. corporate attitudes and culture, process orientation, cross-functional coordination, supplier/customer relationships), formal process for continuous improvement (e.g. analysis tools, benchmarking, measurement), and employee ownership of improvement (e.g. training, team approaches, reward and recognition).

While the suggestions and insights pertaining to the individual characteristics of logistics improvement are instructive, an understanding of the causal relationships among them and between them and customer satisfaction is fundamental to the development of a true quality improvement ‘process’ for achieving customer satisfaction. The A.T. Kearney study made no attempt, however, to determine causal relationships between the methods and characteristics and customer outcomes.

The Global Logistics Research Team at Michigan State University undertook a major study of how some of the world’s best-managed companies use logistics to achieve competitive superiority (The Global Logistics Research Team at Michigan State University, 1995). The objective of the study was ‘to help managers exploit logistics to attract and retain selected customers’ (p.17). Survey respondents represented nearly 3700 firms from 11 countries in North America, Europe and the Pacific Basin. Additionally, 111 firms were interviewed. A number of the quality management concepts covered in the A.T. Kearney study were also included in this seminal research on world class logistical practices.

For example, the study proposed a Logistics Competency Model comprised of four competencies: Positioning, Integration, Agility and Measurement. Positioning encompassed strategic planning, supply chain alliances, and several employee components including empowerment, learning and teaming. Supply chain unification is also a key capability for Integration. Information sharing and connectivity among supply chain members are important to achieving integration. Measurement entailed the extension of performance measurement systems across both internal and external logistical processes, as well as benchmarking against best practice performance. Finally, Agility reflected the desired customer outcome and was defined as “The achievement and retention of competitiveness and customer success”. (p. 183).

Many of the ‘world class propositions’ and corollaries developed by the research team indicate an expectation of continued relevance of logistics quality management concepts during the early 21st century. For instance, in managing change it was projected that world class firms would increasingly sharpen visioning skills and capabilities and would maintain a vigil on continuous improvement. Increased emphasis on and importance of measurement, strong supply chain relationships, and reward and recognition systems were also projected.

The research team employed three approaches to determine whether being world class equates to superior performance. First, correlation analysis was used to determine whether world class logistics practices had an impact on perceived logistics performance relative to major competitors. Each respondent firm was assigned a world class logistics index, and the index scores were correlated with 32 logistics performance measures. Second, the research examined respondents’ intensity of benchmarking and reported performance perceptions to determine whether firms that benchmark perceive superior logistics performance. Third, world class index scores were correlated with available publicly reported financial information for a sub-sample of firms to determine whether high level logistical performance will achieve superior financial performance for an organization. The results from the first two approaches supported the contention that firms that engage in world class logistics practices achieve better logistical performance. The results concerning firm financial performance were less conclusive.
Though the Michigan State study reported some empirical evidence that world class practices (including quality management elements) are correlated with better logistics performance, causal relationships between individual management components and customer satisfaction with logistics performance were not determined. To explore such relationships it is necessary to develop quality management constructs and hypothesized causal relationships. These are addressed in the following section.

3. QUALITY MANAGEMENT CONSTRUCTS AND CAUSAL HYPOTHESES

As noted earlier, the Deming, Juran, Crosby and Baldrige perspectives each imply quality management should be viewed as a causal process. In general, the implied process is that committed leadership causes the activities and practices of the business system, which in turn, cause the desired outcomes. Ten constructs of quality management were used in the proposed causal network of leadership, system activities and outcomes considered in this study. Each construct is related to a component of the Baldrige criteria.

3.1. Constructs

**Leadership**, defined as the commitment to logistics work improvement by senior and supervisory management, is the ‘driving’ component assumed to cause system activities associated with the Baldrige categories of information and analysis, human resources development and process management. The **Information** construct is associated with the Baldrige information category, and is defined as the availability of performance and productivity data by logistics function and activity. **Training, Teamwork** and **Morale** are constructs associated with the Baldrige human resource category. Training is defined as the organizational commitment and actions to the development of skills, abilities and knowledge. Teamwork is defined as the collaborative efforts to engage in coordinated activities, and Morale is defined as the confidence of employees in work efforts.

Three constructs are associated with the Baldrige category of process management. **Supplier Management** is defined as the communication, evaluation and relationship building efforts with suppliers. **Benchmarking** is defined as the efforts to identify and observe best competitive practices. Finally, **Work Measurement** is defined as the efforts to measure, compare, and analyze work performance and improvement.

**Operational Results and Customer Satisfaction** are the constructs viewed as the desired logistics performances. Operational Results is defined as the effectiveness, efficiency and costs of logistics activities, and is associated with the Baldrige quality and operational results category. Customer Satisfaction is defined as the ability to assess and meet customer requirements with the logistics performance, and is reflective of the Baldrige customer focus and satisfaction category.

3.2. Causal hypotheses

Juran (1981) considers the commitment to logistics work improvement by senior and supervisory management a major determinant of successful quality management implementation. However, Deming’s (1986) perspective is that system factors, rather than individual differences, have the direct impact on desired outcomes. Thus, business outcomes are viewed as directly affected by system factors, and only indirectly impacted by leadership. The continuous work movement has placed great emphasis on the use of teams (McKee, 1992), benchmarking practices (Kemp, 1989), training (Garvin, 1993), and work measurement methods (Modarress and Ansari, 1989). Leadership is hypothesized to have a direct effect on these system factors, as stated below.

\[\begin{align*}
H_1 & \quad \text{Leadership is a significant positive direct cause of Teamwork.} \\
H_2 & \quad \text{Leadership is a significant positive direct cause of Training.} \\
H_3 & \quad \text{Leadership is a significant positive direct cause of Benchmarking.} \\
H_4 & \quad \text{Leadership is a significant positive direct cause of Work Measurement.}
\end{align*}\]

The system factors are assumed to be interrelated. Benchmarking, the basis for comparisons, is hypothesized to be a direct cause of the system factors that require competitive standards, Work Measurement and Supplier Management. The use of teams implies the need for knowledge concerning group dynamics. Therefore, Teamwork is assumed to be a cause of Training. Work
measurement methods should provide the means to summarize data into meaningful information. Thus, it is assumed that Work Measurement is a cause of Information. Formally stated,

\[ H_5 \] Benchmarking is a significant positive direct cause of Supplier Management.

\[ H_6 \] Benchmarking is a significant positive direct cause of Work Measurement.

\[ H_7 \] Work Measurement is a significant positive direct cause of Information.

\[ H_8 \] Teamwork is a significant positive direct cause of Training.

Employee morale is viewed as a human resource activity under the Baldrige framework. It is hypothesized that increased effort with the other human resource activities of training and teamwork will have the effect of increased employee morale. Further, the perception of ‘knowing what is going on’, as conveyed by the availability of information, is viewed as a potentially significant cause of employee morale. Hypothesis statements of these three direct causes of employee morale follow.

\[ H_9 \] Training is a significant positive direct cause of Morale.

\[ H_{10} \] Teamwork is a significant positive direct cause of Morale.

\[ H_{11} \] Information is a significant positive direct cause of Morale.

The outcome of operational results is assumed to be directly influenced by the Training, Teamwork and Morale factors in the human resources domain. The process management factors of benchmarking and Work Measurement are assumed to be indirect causes of Operational Results, mediated by Supplier Management and Information. Information and Supplier Management are hypothesized to have a direct positive effect on Operational Results. The hypothesized direct causes of Operational Results are formalized below.

\[ H_{12} \] Training is a significant positive direct cause of Operational Results.

\[ H_{13} \] Teamwork is a significant positive direct cause of Operational Results.

\[ H_{14} \] Information is a significant positive direct cause of Operational Results.

\[ H_{15} \] Supplier Management is a significant positive direct cause of Operational Results.

\[ H_{16} \] Morale is a significant positive direct cause of Operational Results.

Greater customer satisfaction is assumed to be directly caused by greater teamwork efforts, increased employee morale and operational results. Formally stated,

\[ H_{17} \] Teamwork is a significant positive direct cause of Customer Satisfaction.

\[ H_{18} \] Morale is a significant positive direct cause of Customer Satisfaction.

\[ H_{19} \] Operational Results is a significant positive direct cause of Customer Satisfaction.

The nineteen hypotheses provided the basis for postulating a causal network for the ten constructs, and may be formalized by nine construct equations, as shown below.

\[
\begin{align*}
\text{Teamwork} & = \beta_1 \text{Leadership} + \text{Error}_1 \\
\text{Training} & = \beta_2 \text{Leadership} + \beta_8 \text{Teamwork} + \text{Error}_2 \\
\text{Benchmarking} & = \beta_3 \text{Leadership} + \text{Error}_3 \\
\text{Work Measurement} & = \beta_4 \text{Leadership} + \beta_5 \text{Benchmarking} + \text{Error}_4 \\
\text{Supplier Management} & = \beta_6 \text{Benchmarking} + \text{Error}_5 \\
\text{Information} & = \beta_7 \text{Work Measurement} + \text{Error}_6 \\
\text{Morale} & = \beta_8 \text{Training} + \beta_{10} \text{Teamwork} + \beta_{11} \text{Information} + \text{Error}_7 \\
\text{Operational Results} & = \beta_{12} \text{Training} + \beta_{13} \text{Teamwork} + \beta_{14} \text{Information} + \beta_{15} \text{Supplier Management} + \beta_{16} \text{Morale} + \text{Error}_8 \\
\text{Customer Satisfaction} & = \beta_{17} \text{Teamwork} + \beta_{18} \text{Morale} + \beta_{19} \text{Operational Results} + \text{Error}_9.
\end{align*}
\]

The null hypothesis \( \beta_j = 0 \), with the one-sided alternative \( \beta_j > 0 \), provided a statistical test for each hypothesis \( H_j \). Finally, Benchmarking and Teamwork were assumed to have a positive association, but not as a causal relationship.
Benchmarking and Teamwork have a significant positive association.

4. RESEARCH DESIGN

4.1. The sample
The logistics personnel selected for the sample were shipper members of the American Society of Transportation and Logistics who had job titles reflecting middle and senior management level responsibilities. The data were collected in late 1995 to early 1996. All potential respondents were employees in either separate geographical locations or separate firms. The questionnaire was a mailed computer disk. The disk provided computer-assisted interviewing, and eliminated potential questionnaire to data coding errors (Sawtooth Software, 1995). Also, the program does not retain answers if the respondent quits the program before completing the questionnaire. Thus, each of the usable responses has no missing data.

A total of 340 questionnaires were mailed, 99 were returned, and 88 were usable for a 26% effective response rate. In terms of respondent characteristics, 91% are male, 53% are age 45 or older, and 32% have earned a graduate college degree. The most frequent job titles were Traffic Managers (29%), Director of Transportation (13%) and Vice-President (12%).

4.2. Construct questionnaire items
The items used to form scales for the ten constructs, except Morale, were Likert type five-point measurement scales selected from a larger battery, with reported reliabilities (Saraph et al., 1989). The two items designed to measure non-supervisory and management morale also used five-point scales. The wording in all questionnaire items was specialized to the logistics environment. Table 1 displays the constructs and the associated questionnaire items.

4.3. Measure development and validation
Multi-item responses were summed to form composite scale measurements for each construct. The psychometric properties of the composite scales and measured indicators were assessed by means of confirmatory factor analysis models, as well as the traditional reliability methods producing Cronbach’s alpha (Cronbach, 1951), and adjusted item-to-total correlations. The relative large number of constructs and measured variables required assessing scales by examining smaller confirmatory models (Bentler and Chou, 1987). Four related sets of measures were the basis for the confirmatory analysis: (1) indicators of Leadership, which is the antecedent of the system factors, (2) measures associated with the human resources functions of Training, Teamwork and Morale, (3) indicators of the information and business process system factors: Information, Benchmarking, Work Measurement and Supplier Management, and (4) the outcome measures of Operational Results and Customer Satisfaction.

The composite scales had alpha coefficients that ranged from 0.78 to 0.91, each of which surpassed the recommended minimum standard of 0.70 (Nunnally, 1988). The composite scale correlations, means, standard deviations and alpha coefficients are shown in Table 2.

Confirmatory factor analysis models were fitted to each of the four sets of measured indicators to assess if the measures can be considered tau-equivalent (Joreskog and Sorbom, 1989). A tau-equivalent model provides a test of the correct number of factors (construct unidimensionality), no cross-factor loadings, and equal factor loadings for indicators of a given factor. A model that confirms tau-equivalent measures for a specified set of factors allows Cronbach’s alpha reliability coefficient to be used as the basis for determining the amount of measurement error variance of a composite sum index (Bollen, 1989).

Each of the four confirmatory measurement models were found to be statistically acceptable at the 0.05 level of significance. Further, the goodness-of-fit index and the comparative fit index exceeded 0.90 for each model, which is conventional descriptive standard for adequate model fit. Since the tau-equivalent models were supported, the estimated composite scale reliability was taken as the proportion of the scale variance that was predictable from the underlying construct (Joreskog and Sorbom, 1982). The complement of the reliability coefficient was considered the proportion of the composite scale variance that was unreliable and attributed to measurement
Table 1. Quality management constructs and indicators

<table>
<thead>
<tr>
<th>Construct</th>
<th>Questionnaire indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership: the commitment to logistics work improvements practices by senior and supervisory management. Scale reliability = 0.91</td>
<td>The extent to which senior management is committed to work improvement programs</td>
</tr>
<tr>
<td></td>
<td>The acceptance of responsibility for work improvement by major department heads</td>
</tr>
<tr>
<td></td>
<td>Specificity of work improvement goals</td>
</tr>
<tr>
<td>Information: the availability of productivity and performance data by logistics function and activity. Scale reliability = 0.90</td>
<td>Availability of warehouse or distribution center productivity data</td>
</tr>
<tr>
<td></td>
<td>Availability of inventory data</td>
</tr>
<tr>
<td></td>
<td>Availability of order processing productivity and performance data</td>
</tr>
<tr>
<td></td>
<td>Availability of transportation productivity and performance data</td>
</tr>
<tr>
<td></td>
<td>Extent to which order processing productivity and performance data are provided by activity</td>
</tr>
<tr>
<td>Training: the organizational commitment and actions to the development of skills, abilities, and knowledge. Scale reliability = 0.88</td>
<td>The commitment of senior management to employee training</td>
</tr>
<tr>
<td></td>
<td>The availability of resources for employee training</td>
</tr>
<tr>
<td></td>
<td>The amount of specific work-skills training, technical and vocational, given to non-supervisory employees</td>
</tr>
<tr>
<td></td>
<td>The amount of team building and group dynamics training</td>
</tr>
<tr>
<td>Teamwork: the propensity to engage in coordinated activities. Scale reliability = 0.89</td>
<td>Frequency of use of cross-functional teams</td>
</tr>
<tr>
<td></td>
<td>The use of empowered work teams</td>
</tr>
<tr>
<td>Benchmarking: the efforts to identify and observe best competitive practices. Scale reliability = 0.82</td>
<td>The extent of benchmark comparisons with key competitors</td>
</tr>
<tr>
<td></td>
<td>The degree to which best practices of other organizations have been identified</td>
</tr>
<tr>
<td></td>
<td>Frequency of visits to other organizations to investigate best practices first hand</td>
</tr>
<tr>
<td>Supplier Management: the communication, evaluation and relationship building efforts with suppliers. Scale reliability = 0.78</td>
<td>The extent to which suppliers are selected on a quality basis rather than a price basis</td>
</tr>
<tr>
<td></td>
<td>The thoroughness of the supplier rating system</td>
</tr>
<tr>
<td></td>
<td>The extent to which longer term relationships are offered to suppliers</td>
</tr>
<tr>
<td>Work Measurement: the efforts to measure, compare, and analyze work performance and improvement. Scale reliability = 0.86</td>
<td>The extent of comparative measurement to an established standard</td>
</tr>
<tr>
<td></td>
<td>The extent of use of charts and graphs to measure and monitor work performance and improvement</td>
</tr>
<tr>
<td></td>
<td>The extent of use of statistical methods to measure and monitor work performance and improvement</td>
</tr>
<tr>
<td>Morale: the confidence of employees in work efforts. Scale reliability = 0.84</td>
<td>The morale of non-supervisory logistics employees</td>
</tr>
<tr>
<td></td>
<td>The morale of logistics managers</td>
</tr>
</tbody>
</table>

(continued overleaf)
error. This resulted in the observed composite scale variance being separated into a reliable part, attributed to the underlying construct, and an unreliable part, the residual.

5. ANALYSIS AND FINDINGS

5.1. Structural equation analysis

The sample data were fitted to a causal model of the construct equations specified above. Structural equation analysis provides measures of overall model adequacy, estimates of specifying parameters, and tests of significance for each of the model parameters specified by the 20 hypotheses. The overall fit of the model was acceptable ($\chi^2_{25} = 18.78$, $P = 0.81$), with the goodness-of-fit and the comparative fit indexes equal to 0.96 and 1.00, respectively. However, four structural path coefficients were not significantly different from zero, based on the $z$-ratio test statistic and the associated $P$-value. Hypothesis $H_9$: Training is a significant positive direct cause of Morale was rejected ($\beta_9 = 0.09, z = 1.09, P = 0.14$). Hypothesis $H_{10}$: Teamwork is a significant positive direct cause of Morale was rejected ($\beta_{10} = -0.05, z = -0.39, P = 0.85$). Hypothesis $H_{13}$: Teamwork is a significant positive direct cause of Operational Results was rejected ($\beta_{13} = -0.04, z = -0.27, P = 0.61$). Also, hypothesis $H_{16}$: Morale is a significant positive direct cause of Operational Results was rejected ($\beta_{16} = 0.11, z = 0.81, P = 0.29$). The coefficient linking Customer Satisfaction and Teamwork was also relatively small ($\beta_{17} = 0.14, z = 1.45, P = 0.07$), and slightly above the traditional 0.05 level of significance. However, Teamwork did make a positive contribution to Customer Satisfaction, as discussed below, thus the hypothesis, $H_{17}$: Teamwork is a significant positive direct cause of Customer Satisfaction, was retained. All the other research hypotheses were retained, based on non-zero model parameters as indicated by $P$-values of 0.05 or less.

Table 1—contd

<table>
<thead>
<tr>
<th>Construct</th>
<th>Questionnaire indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Results: the effectiveness, efficiency, and cost performances of logistics activities. Scale reliability = 0.79</td>
<td>Logistics cost performance</td>
</tr>
<tr>
<td>Customer Satisfaction: the ability to assess and meet customer expectations with logistics performance. Scale reliability = 0.78</td>
<td>Effectiveness and efficiency of transaction processes</td>
</tr>
<tr>
<td></td>
<td>Order cycle time</td>
</tr>
</tbody>
</table>

| Table 2. Sample correlations, standard deviations, means and reliabilities |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|                          | Leader       | Team         | Train         | Bench        | Measure      | Supply        | Inform       | Morale       | Results      | CSat         |                         |
|                          |              |              |              |              |              |              |              |              |              |              | Note: A scale mean and standard deviation is based on the composite sum divided by the number of indicators. |
|                          | 1.00         | 0.42         | 0.53         | 0.46         | 0.53         | 0.39         | 0.32         | 0.20         | 0.39         | 0.39         | A scale mean and standard deviation is based on the composite sum divided by the number of indicators. |
|                          | 0.42         | 1.00         | 0.50         | 0.61         | 0.44         | 0.37         | 0.20         | 0.09         | 0.29         | 0.29         |                         |
|                          | 0.53         | 0.50         | 1.00         | 0.49         | 0.59         | 0.40         | 0.15         | 0.16         | 0.40         | 0.40         |                         |
|                          | 0.46         | 0.61         | 0.49         | 1.00         | 1.00         | 0.45         | 0.31         | 0.31         | 0.34         | 0.34         |                         |
|                          | 0.53         | 0.44         | 0.38         | 0.59         | 0.59         | 0.37         | 0.56         | 0.12         | 0.36         | 0.36         |                         |
|                          | 0.39         | 0.40         | 0.40         | 0.45         | 0.45         | 0.40         | 0.36         | 0.16         | 0.43         | 0.43         |                         |
|                          | 0.39         | 0.44         | 0.32         | 0.45         | 0.45         | 0.37         | 0.36         | 0.16         | 0.32         | 0.32         |                         |
|                          | 0.32         | 0.40         | 0.32         | 0.45         | 0.45         | 0.37         | 0.36         | 0.12         | 0.43         | 0.43         |                         |
|                          | 0.20         | 0.20         | 0.15         | 0.23         | 0.23         | 0.30         | 0.56         | 0.21         | 0.36         | 0.36         |                         |
|                          | 0.29         | 0.20         | 0.15         | 1.00         | 1.00         | 0.31         | 0.62         | 0.15         | 0.28         | 0.28         |                         |
|                          | 0.40         | 0.39         | 0.32         | 0.39         | 0.39         | 0.31         | 0.62         | 0.15         | 0.28         | 0.28         |                         |
|                          | 0.34         | 0.39         | 0.34         | 0.39         | 0.39         | 0.31         | 0.62         | 0.15         | 0.28         | 0.28         |                         |
|                          | 0.03         | 0.30         | 0.27         | 0.30         | 0.30         | 0.31         | 0.62         | 0.15         | 0.28         | 0.28         |                         |
|                          | 0.10         | 0.30         | 0.27         | 0.30         | 0.30         | 0.31         | 0.62         | 0.15         | 0.28         | 0.28         |                         |
|                          | 3.58         | 2.85         | 2.17         | 2.61         | 2.61         | 2.35         | 0.86         | 0.79         | 0.96         | 0.96         |                         |
|                          | 1.16         | 1.22         | 1.17         | 1.17         | 1.17         | 1.35         | 0.86         | 0.79         | 0.96         | 0.96         |                         |
|                          | 0.82         | 0.16         | 0.87         | 0.87         | 0.87         | 0.87         | 0.86         | 0.79         | 0.96         | 0.96         |                         |
|                          | 0.61         | 0.18         | 0.82         | 0.82         | 0.82         | 0.82         | 0.86         | 0.79         | 0.96         | 0.96         |                         |
|                          | 0.91         | 0.89         | 0.88         | 0.88         | 0.88         | 0.88         | 0.86         | 0.79         | 0.96         | 0.96         |                         |
|                          | 0.79         | 0.79         | 0.79         | 0.79         | 0.79         | 0.79         | 0.79         | 0.79         | 0.79         | 0.79         |                         |

Table 2—contd

<table>
<thead>
<tr>
<th>Construct</th>
<th>Questionnaire indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Results: the effectiveness, efficiency, and cost performances of logistics activities. Scale reliability = 0.79</td>
<td>Logistics cost performance</td>
</tr>
<tr>
<td>Customer Satisfaction: the ability to assess and meet customer expectations with logistics performance. Scale reliability = 0.78</td>
<td>Effectiveness and efficiency of transaction processes</td>
</tr>
<tr>
<td></td>
<td>Order cycle time</td>
</tr>
</tbody>
</table>

Note: A scale mean and standard deviation is based on the composite sum divided by the number of indicators.
A revised causal model, omitting the rejected structural linkages, was fit to the data ($\chi^2_{29} = 20.94, P = 0.86$). The construct equations were used to assess the impact of causal variables in terms of relative magnitude and predictive magnitude. Assessment of relative magnitude was based on standardizing each variable to a mean of zero and a variance of one. The resulting standardized path coefficients, shown in Fig. 1, measure the direct causal effects on response variables. Indirect causal effects were measured by the sum of the products of standardized path coefficients on non-direct paths from the causal variable to the response variable (Fox, 1984). The total relative magnitude of the causal influence of a causal construct on a response construct was estimated by the sum of the direct effect and indirect effects.

5.2. Influences on operational results and customer satisfaction

Supplier Management, Training and Information had significant direct effects on Operational Results, with the standardized path coefficients shown in Fig. 1. The Operational Results construct had 43% ($R^2 = 0.43$) of its variance accounted for by these direct paths. The constructs with the largest relative influence on Operational Results, based on total standardized effect available from Table 3, were Leadership (indirect effect = 0.39), Supplier Management (direct effect = 0.34), Training (direct effect = 0.29), Benchmarking (indirect effect = 0.29), and Information (direct effect = 0.28).

The influence of leadership was mediated through five paths displayed in the causal model of Fig. 1. The path with the largest contribution to the indirect effect of Leadership on Operational Results was Leadership→Training→Operational Results, with a contribution of $\beta_2 \beta_{12} = 0.42 \times 0.29 = 0.12$ to the 0.39 total. The second largest contributor was Leadership→Benchmarking→Supplier Management→Operational Results, with a contribution of $\beta_5 \beta_7 \beta_{15} = 0.56 \times 0.59 \times 0.34 = 0.11$.

Morale was found to have no significant influence, direct or indirect, on Operational Results. Also, the influence of Teamwork was indirect and small, as noted above. However, both Morale and Teamwork did have influences on Customer Satisfaction.

The magnitude of the direct and indirect effects for all constructs are displayed in Table 3. Also, the explanatory strength of each construct equation is summarized in the last row Table 3, labeled as $R^2$.

Operational Results, Teamwork and Morale had significant direct effects on Customer Satisfaction. Forty-one per cent ($R^2 = 0.41$) of the Customer Satisfaction variance was accounted for by direct paths from these constructs. The constructs with the greatest relative influence on Customer Satisfaction, based on total standardized effects, were Operational Results (direct effect = 0.46), Leadership (indirect effect = 0.29), Morale (direct effect = 0.24), and Teamwork (direct effect = 0.17, indirect effect = 0.05). Seven paths mediated the influence of Leadership, with the path of Leadership→Teamwork→Customer Satisfaction contributing the largest amount ($\beta_1 \beta_{17} = 0.46 \times 0.17 = 0.08$) to the indirect effect of Leadership on Customer Satisfaction.

A summary of the hypothesis testing results is provided in Table 4. Sixteen of the 20 hypotheses are supported. The implications of these findings are discussed in the next section.
The primary objective of this study was to investigate the influence of quality management components on logistics performance operational results and customer satisfaction. A causal model of quality management was developed based on 20 hypotheses concerning relationships among the criteria of the Baldrige categories. Multi-item scales provided measurements of the quality management constructs based on survey data from logistics professionals. Structural equation modeling provided an overall assessment of the proposed causal network and the evaluation tests for each hypothesis. Four hypotheses were rejected, and the resulting modified model provided an assessment of the relative importance of quality management influences on operational results and customer satisfaction. The findings of both the confirmed causal relationships and the rejected hypotheses have some important implications for management.
First, committed leadership is critically important. Leadership was found to exert the strongest influence on Operational Results. Further, the influence of Leadership on Customer Satisfaction was second only to that of the actual logistics performance of the firm (i.e. Operational Results), with most of the effects being indirect, resulting from eight paths. Thus, as is often asserted by TQM proponents, top management commitment to quality improvements in logistics appears to be a prerequisite to achieving internal logistics operational improvements and increasing customer satisfaction. Though the influence of Leadership was mediated by the other constructs, it is apparent that employees take their cue from corporate leaders.

The importance of the human resource category constructs on Customer Satisfaction is evidenced by Morale and Teamwork having only slightly less total influence on Customer Satisfaction than does Leadership, and the model indicates most of the influence resulting from a direct path. Indeed, the causal model developed in this study identified only three constructs having a direct path to Customer Satisfaction—Operational Results, Morale and Teamwork. These results support TQM’s emphasis on the firm’s internal customers, i.e. employees, even if one is interested only in the ultimate objective of improving external customer satisfaction and not because it is the “right thing to do”.

Interestingly, the hypothesized relationships between each of these two human resource constructs and Operational Results were not confirmed by our analysis. In other words, Morale and Teamwork were found not to have a significant influence on the efficiency and effectiveness of logistics activities. Instead, those constructs related to preparing (i.e. Training) and enabling (i.e. Benchmarking and Information) employees to do their jobs were found to influence Operational Results. The lesson from these results is that satisfied employees and the use of employee teams, in and of themselves, do not produce desired operational performance. Firms need to invest the necessary resources and time in training programs, information systems, and benchmarking to affect efficiency and effectiveness of their logistics operations.

Finally, it is interesting to note that the morale of logistics employees is most significantly, and favorably, affected by the availability of logistics performance and productivity data (i.e. Information) and efforts to measure, compare and analyze work performance and improvement (i.e. Work Measurement). The hypothesized relationships between Training and Morale and between Teamwork and Morale were rejected. While training and teamwork are linked to other benefits to the firm, logistics employees’ morale appears to be affected more by efforts to objectively assess employee and organizational logistics performance. These results contradict the assertion by some that employees do not like accountability.

The study has a number of limitations that should be noted. First, the sampling frame was restricted to members of a single professional organization, AST&L, and thus findings may not be generalizable to the general shipper population. Although the sample demographic profile is similar to that of the AST&L membership (Jerman and Anderson, 1989), some caution is advised in making generalizations beyond the sample. Second, the sample size is adequate for modeling, but small in reference to the AST&L membership and to the population of shipper firms. Thus, the potential impacts of firm size, industry, and respondent position on the results could not be investigated. However, the respondents represented a wide range of experience with quality management practices, and firm level of experience was found to have very little influence on perceived logistics operational results, employee outcomes, or customer satisfaction (Anderson et al., 1996). Third, non-response bias is possible due to the form of data collection (i.e. a computer disk was used rather than the typical paper and pencil questionnaire).

The causal model developed in this paper provides an understanding of how each of the various concepts and practices associated with quality management affects logistics customer satisfaction and operational performance. Such an understanding is essential for management to achieve the potential improvements quality practices may provide.

REFERENCES


