

BUILDING A QUALITY IMPROVEMENT FRAMEWORK IN THE TRANSPORTATION INDUSTRY

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ABSTRACT

Not much empirical research work linking quality assessment and improvement programs exist to date for the service industry and particularly for the transportation industry. The lack of such linkages has then resulted in firms using initiatives in a piecemeal manner and misunderstanding their impact, that is, their potential or long term impact. This paper is aimed at identifying quality improvement practices in the transportation industry in Kwara, Ogun, and Oyo states, categorizing them and linking them with performance outcomes. To achieve this, primary data on quality practices and measures of performance in the transportation industry was collected through administration of questionnaire for Kwara, Ogun, and Oyo states. Groups of Quality Constructs (Initiatives) were formed using factor analysis and Success of Transportation Quality Programs (STQP) regressed on the Quality Constructs identified. The result shows that five Quality Constructs were paramount Quality Practices in the industry of which four are found to be significant to Success of the Transportation Quality Programme (STQP).

1.0 INTRODUCTION

Quality management for a long time has become an important strategic tool for both manufacturing and service industries striving to attain competitive success. Intense competition among various firms especially in the transportation industry has forced many organizations to re-examine how they manage quality as they seek to enhance product quality, customers' satisfaction and overall competitiveness.

To date, little empirical research exists describing the quality assessment and improvement programme for the transportation sector. Most of the existing empirical researches related to transportation quality are not comprehensive enough. The lack of well defined linkages between transportation quality practices and performance outcomes have as a consequence resulted in firms using initiatives in a piecemeal manner without understanding the potential or long-term impacts (Carman 1993; Mentzer and Conrad 1991). Not much has therefore been done in the transportation industry to link quality practices or initiatives to indicators of firms' success.

Several theoretical articles discussed and identified various transportation activities that would be considered consistent with Total Quality Management (TQM) practices (Gourdin 1998; Saylor 1990; Mentzer and Conrad 1991). These activities include, top management commitment, staff training, maintenance of equipment, continuous improvement, customers' feedback, information, quality team, employee empowerment, statistical quality technique, management and employee relation, non-monetary reward and benchmarking. Only four measures of performance are however identified which are: number of vehicles, number of customers, overhead cost and income.

The quality practices in the industry are classified, with the aid of factor analysis to derive a classification of transportation quality elements and the outcome is then used as the basis for assessing current quality practices in the industry.

1.1 FORMATION OF RESEARCH CONSTRUCT

Several surveys have attempted to determine common practices relating to excellence in the transportation industry (Carman 1993; Kearney 1991, Ernst and Whinney 1987). Most of these researches used survey or case study data as the basis for its findings (Chow and Poist 1984, Hopkins et al 1993, Truitt and Haynes 1994).

Theoretical articles discussed and identified various transportation activities that would be considered consistent with Total Quality Management (TQM) practices (Gourdin 1988, Saylor 1990, Mentzer and Conrad 1991). These activities include use of performance measures, involvement of all processes in quality improvement efforts; focus on partnership agreements or strategic alliances, staff training, maintenance, equipment and labour support, customer relation, continuous improvement of the system, concentration on failure prevention to reduce cost and involvement of all employees in quality improvement efforts.

Using this previous research, a classification of transportation quality elements was derived and used as the basis for assessing current quality practices in the industry. The following four interrelated constructs were identified. Strategic: organizational initiatives, Human resources initiatives, Strategic quality initiatives and Tactical quality initiatives.

STRATEGIC ORGANIZATIONAL INITIATIVES

The most often cited in Total Quality Management (TQM) literature that is crucial to the success of a quality improvement programme was the involvement of top management. Without planning, support, patience and leadership from the management, quality improvement programme can become large drains of time, efforts and resources for the company, yielding few tangible results.

Top management commitment involves activities that are directly related to the long-term strategic goals of the organization. Experience has shown that top management commitment must be continuous with respect to the quality management process or else any initiatives in this regard will eventually be abandoned. The primary goal of this initiative is to provide a long-term vision or guiding principle for the organization.

HUMAN RESOURCE INITIATIVES

For excellence performance of any firm, people must be recognized as the organization's most important resource. Well-established companies foster excellence within their workforce by exhibiting close supportive management/labour relations and by providing periodic training to maintain and improve job skills. Employee empowerment is also not left out in making decision that will reduce response time and prevent problems and encourage team work through the formation of quality teams.

Therefore, assessing performance among human resource initiative should include the level of top management support, training and education frequency, financial reward for quality improvement and the use of teamwork structure.

STRATEGIC QUALITY INITIATIVES

Strategic quality initiatives include long-term quality related activities that define the overall transportation quality programme and ultimately define the goals of the operational or tactical quality initiatives. Long-term agreement with customers and other competitors in the industry can provide higher level of quality and attract more customers, ultimately resulting in greater levels of competitiveness and profits. Strategic alliance provides a means for quickly adapting to changing markets.

Benchmarking, both inside and outside the industry is essential if the firms are to maintain and improve competitiveness. Benchmarking activities may prove more fruitful when conducted within business outside the industry, because the information exchange may even provide a source of new innovative services and greater competitive advantage. Information systems and frequent interaction with customers and other competitors can therefore be utilized to store, retrieve and exchange strategic information.

TACTICAL QUALITY INITIATIVES

Tactical quality initiatives define the specific quality tools as the tactical or customers' interaction level. Fast integrated and user friendly information systems are necessary for transportation firms to track operations, communicate internally and externally and compete effectively. Tracking key performance indicators with an adequately maintained information system database allows transportation firms to periodically assess employee, department and vendor performance quickly, while indicating areas requiring improvement.

Effective information system enables company to detect mistakes or deteriorating condition early and prevent costly mistakes and failure. Tactical quality initiatives include periodic preventive maintenance on equipment and facilities. Transportation firms therefore need to frequently assess the performance level of their equipment and facilities and upgrade them as necessary.

1.2 SOURCE AND METHOD OF DATA COLLECTION

The data used in this work is a primary one. A transportation quality assessment survey is designed in form of a questionnaire and administered on a number of selected staff of the transportation industry covering some selected towns in Kwara, Osun and Oyo states.

The questionnaire is divided into three sections: A-General information, B-Quality practices and C-Measure of performance. Section A is on the business type, age of the transportation firm, weekly returns and staff strength; section B is mainly on various quality practices of the transportation firms, while section C is on measure of performance, which includes increase in number of customers, number of vehicles, yearly returns and total overhead cost.

The responses in section B are ranked using likert scale from 5 to 1 representing very important, important, do not know, not important and not very important respectively. Responses in section C are also ranked on the likert scale from 5 to 1 representing very successful, successful, could not say, not successful and completely unsuccessful respectively.

2.0 REDUCTION OF OBSERVABLE VARIABLES TO SOME RELATED UNOBSERVABLE VARIABLES USING FACTOR ANALYSIS

Common Factor Analysis is used to investigate unobservable variables using observable variables that are related to the unobservable variables. This is done by extracting factors using

principal component method and interpreting the factor loadings using varimax approach. Factor Analysis forms k -cluster of variables known as k -factors such that a cluster of variables is assumed to be measuring a particular unobservable variable.

The statistical model of factor analysis is:

$$Y = \Lambda X + \epsilon$$

where Y is a $(p \times 1)$ random vector of observable variables

X is a $(k \times 1)$ vector of unobservable factors

Λ is a $(p \times k)$ matrix of regression weights with $R(\Lambda) = k$ where $k < p$ and ϵ is a $(p \times 1)$ vector of random error.

It is further assumed that X and E are statistically independent with

$$V(X) = I \text{ and } V(\epsilon) = \Psi, \text{ diagonal matrix}$$

This implies that $V(Y) = \Sigma$

Has the structure $V(Y) = \Lambda \Lambda' + \Psi$

The common factor model can be expanded to form linear common factor analysis model equations

$$y_1 = \lambda_{11}x_1 + \lambda_{12}x_2 + \lambda_{13}x_3 + \dots + \lambda_{1k}x_k + \epsilon_1$$

$$\vdots$$

$$y_i = \lambda_{i1}x_1 + \lambda_{i2}x_2 + \lambda_{i3}x_3 + \dots + \lambda_{ik}x_k + \epsilon_i$$

$$\vdots$$

$$y_p = \lambda_{p1}x_1 + \lambda_{p2}x_2 + \lambda_{p3}x_3 + \dots + \lambda_{pk}x_k + \epsilon_p$$

Where λ_{ij} are regression weights and are generally termed factor loading and the residuals, ϵ_i are unique factors. The correlation among all pairs of residuals (unique part) is 0 for $i \neq j$, that is, $\text{cov}(\epsilon_i, \epsilon_j) = 0$. Thus each equation is divided into two parts, that is, common part

$c_i = \sum_{t=1}^k \lambda_{it} x_t$ and the unique part ϵ_i . This implies that, the Σ , that is, $\text{var}(Y)$ can be partitioned into two thus;

$$\sigma_{c_i}^2 = \lambda_{i1}^2 + \lambda_{i2}^2 + \lambda_{i3}^2 + \dots + \lambda_{ik}^2 = \rho_i$$

$$= V(c_i) + V(\epsilon_i)$$

The variance of common part is called the common variance or communality of the response y_i and the variance of the unique part $V(\epsilon_i) = \rho_i$ which is the diagonal element of Ψ , is termed the unique variance or the uniqueness of y_i . The communality is that portion of the variance attributed to the common factors, while the uniqueness is that part of the total variance that is unaccounted for by the factors.

2.1 INTERPRETATION OF FACTOR LOADINGS

After estimating the matrix of factor loadings $\Lambda_{p \times k}$, the next task is the problem of interpreting the loading, λ_{ij} , that is, the correlation coefficient between the i th variable and j th factor. The interpretation would have been straight forward if each variable is highly loaded on at

BUILDING A QUALITY IMPROVEMENT FRAMEWORK IN THE TRANSPORTATION INDUSTRY

most one factor and also if all the factor loadings are both large and positive or near zero. The variables are split into disjoint sets, each of which is associated with one factor. A factor j can then be interpreted as an average measure over variables i for which Z_{ij} is large, that is $Z_{ij} > 0.5$.

Therefore, for clearer interpretation of factor loadings, the factor loading matrix A_{ijk} may be rotated to a simple structure by using an analytic criterion to a simple matrix that can be interpreted.

3.0 STATISTICAL ANALYSIS

3.1 RELIABILITY RESULT

Prior to analyzing responses to the two-item scale of primary importance in this research, that is, transportation quality practices and success of the transportation quality programme, Cronbach's alpha statistic was used to assess the reliability of each scale. The 12 transportation quality practices yielded a standardized α of 0.7780 as in Tables 1A and 1B below indicating that the two scales are reliable (Cronbach 1951). Table 1 gives the result computed using SPSS package.

TABLE 1A: RELIABILITY ANALYSIS OF TRANSPORTATION QUALITY PRACTICES

i	BENCHMARKING
ii	CUSTOMERS FEEDBACK
iii	CONTINUOUS IMPROVEMENT
iv	CUSTOMER SATISFACTION
v	EMPLOYEE EMPOWERMENT
vi	INFORMATION
vii	MANAGEMENT AND EMPLOYEE RELATION
viii	NON-MONETARY REWARD
ix	QUALITY TEAM
x	QUALITY TRAINING
xi	STATISTICAL TECHNIQUES
xii	TOP MANAGEMENT COMMITMENT
	Reliability coefficients
	Number of cases = 35
	Alpha = 0.7610
	Number of items = 12

TABLE 1B: RELIABILITY ANALYSIS OF PERFORMANCE MEASURE

i	INCOME
ii	NO. OF CUSTOMERS
iii	NO. OF VEHICLES
iv	OVERHEAD COST
	Reliability coefficients
	Number of cases = 35
	Alpha = 0.7780
	Number of items = 4

3.2 RESPONSE PROFILE

Tables 2.1 to 2.5 give the various categorizations of the response profile, their frequencies as well as their percentages. The ownership is categorized into three, that is, organized, unorganized private sectors and government owned. For Table 2.1 almost half (48.58%) of the respondents industry are of unorganized private sector followed by 45.71% ownership by organized private sector and 5.71% by government. Most of the respondents are new in the industry as more than half (54.29%) of the respondents have spent less than 5 years in the industry, 20% between 6 and 10 years, 17.14% between 11 and 15 years and only 8.5% spent 15 years and above in the industry as shown in Table 2.2

Also from Table 2.3, 63.71% of the firms employed less than 10 staff, 17.14% employed between 10 and 20 staff, 11.43% employed between 20 and 50 and only 5.72% employed above 50 staff. Moreover, from Table 2.4, 5.71% of the firms earn less than N5,000 in a week, 48.57% of the firms earn between N5,000 and N10,000 weekly, 22.86% firms have their weekly returns between N10,000 and N100,000, 14.29% between N100,000 and N1,000,000 and 8.57% over N1, million.

Furthermore, from Table 2.5, up to 71.43% firms have less than 10 vehicles, 14.28% between 10 and 30 vehicles, 8.57% between 30 and 40 vehicles and only 5.71% have above 40 vehicles. In the area of coverage, as shown in Table 2.6, 74.29% of the firms undertake interstate venture only, while 25.71% undertake both interstate and intrastate venture

TABLE 2: RESPONSE PROFILE

Table 2.1 OWNERSHIP TYPE		
Ownership	Frequency	Percentage
Govt. owned	2	5.71%
Organized private	16	45.71%
Unorganized private	17	48.58%

Table 2.2 AGE IN THE INDUSTRY		
Year	Frequency	Percentage
1 - 5	19	54.29%
6 - 10	4	20.00%
11 - 15	6	17.14%
above 15	3	8.57%

Table 2.3 STAFF STRENGTH		
Number of staff	Frequency	Percentage
Less than 10	23	63.71%
10 - 20	6	17.14%
20 - 50	4	11.43%
Above 50	2	5.72%

Table 2.4

WEEKLY RETURNS

Amount in Naira	Frequency	Percentage
Less than 5,000	2	5.71%
5,000 – 10,000	17	48.57%
10,000 – 100,000	8	22.86%
100,000 – 1,000,000	5	14.29%
Over 1,000,000	3	8.57%

Table 2.5

NUMBER OF VEHICLE

Number of vehicle	Frequency	Percentage
Less than 10	25	71.43%
10 – 30	5	14.28%
30 – 40	3	8.57%
Above 40	2	5.71%

Table 2.6

BUSINESS COVERAGE

Coverage	Frequency	Percentage
Interstate	26	74.29%
Both	9	25.71%

3.3

RESPONSES OF QUALITY PRACTICES AND PERFORMANCE MEASURE

The mean responses for both measures of performance and the transportation quality practices are as shown in the Table 3. Based on likert scale of 5 (very important), 4 (important), 3 (do not know), 2 (not important but necessary) and 1 (not important), the mean assessment for the 12 quality practices ranges from 1.5143 to 3.8571. This suggests that the respondents firms considered some quality practices important and some others not that important but only necessary. The more prominent of the practices includes top management commitment (3.8571), employee empowerment (3.8286), continuous improvement (3.7963), customer feedback (3.5571), management and employee relation (3.7963), and customer satisfaction (3.3880). However, information, non-monetary reward for quality improvement and statistical technique with scores 1.5743, 1.5429 and 1.8571 respectively are considered to be less important quality practices.

In the case of measure of performance, likert scale of 5 (extremely successful), 4 (successful), 3 (could not say), 2 (unsuccessful) and 1 (completely unsuccessful) is used. Only the total overhead cost with average of 2.4286 is rated to be unsuccessful, the remaining three, that is, income, number of customers, and number of vehicles with scores 3.5714, 3.8571 and 3.3429 respectively are rated to be quite successful.

3.4

BIVARIATE CORRELATION OF QUALITY PRACTICES VERSUS MEASURE OF PERFORMANCE

Table 4 shows the results of the bivariate correlation analysis of the 12 transportation quality practices and the four performance measure. Some are significant at $\alpha = 0.05$ while others are at $\alpha = 0.01$. One interesting thing to note is that, all the significant correlation coefficients are positive, indicating that most transportation quality practices are positively correlated with the

quality programme success, that is, incomes, number of customers, number of vehicle and the total overhead cost.

The quality practices that are related with income are customer satisfaction, management-employee relation and non-monetary reward for quality improvement. Non-monetary reward for quality improvement, top management commitment and information are also highly related with the number customers. Furthermore, continuous improvement, customer satisfaction, information, non-monetary reward for quality improvement, quality training and statistical techniques are highly related with total overhead cost. Customer feedback, employee empowerment and quality training are however not significantly correlated with any of the measures of performance.

TABLE 3: RESPONSES ON QUALITY PRACTICES & PERFORMANCE

	Mean	SD	N
QUALITY PRACTICES			
BENCHMARKING	2.0571	1.4940	35
CUSTOMER FEEDBACK	3.2557	1.5280	35
CONTINUOUS IMPROVEMENT	3.7903	0.4937	35
CUSTOMER SATISFACTION	3.8801	0.2780	35
EMPLOYEE EMPOWERMENT	3.8286	1.5046	35
INFORMATION	1.5143	0.8444	35
MANAGEMENT-EMPLOYEE RELATION	3.6286	1.0870	35
NON-MONETARY REWARD	1.5429	1.1966	35
QUALITY TEAM	2.8857	1.7950	35
QUALITY TRAINING	2.5113	1.4425	35
STATISTICAL TECHNIQUES	1.8571	0.8276	35
TOP MANAGEMENT COMMITMENT	3.8571	0.4937	35
PERFORMANCE			
INCOME	3.5714	0.6981	35
NO. OF CUSTOMER	3.8571	0.6011	35
NO. OF VEHICLE	3.3429	0.6835	35
TOTAL OVERHEAD COST	2.4286	0.6081	35

TABLE 4: BIVARIATE CORRELATION OF QUALITY PRACTICES AND PERFORMANCE

	INCOME	NO OF CUSTOMER	NO OF VEHICLE	TOTAL OVERHEAD COST
BENCHMARKING	0.052	-0.184	0.153	0.393
CUSTOMER FEEDBACK	-0.114	0.073	0.093	0.036
CONTINUOUS IMPROVEMENT	0.029	0.177	0.320	0.047
CUSTOMER SATISFACTION	0.318	0.320	0.366	0.433
EMPLOYEE EMPOWERMENT	-0.156	-0.028	0.230	0.113
INFORMATION	0.086	0.294	0.679	0.160
MANAGEMENT-EMPLOYEE RELATION	0.288	0.141	0.216	0.159
NON-MONETARY REWARD	0.322	0.356	0.665	0.479
QUALITY TEAM	0.124	0.066	0.435	0.208

BUILDING A QUALITY IMPROVEMENT FRAMEWORK IN THE TRANSPORTATION INDUSTRY

QUALITY TRAINING	-0.096	0.169	0.442	0.279
STATISTICAL TECHNIQUES	0.095	0.042	0.193	0.359
TOP MANAGEMENT COMMITMENT	0.073	-0.269	0.237	0.112

3.5 REDUCTION OF MEASURES OF PERFORMANCE AND QUALITY PRACTICES USING FACTOR ANALYSIS

With the aid of SPSS, factor analysis was used to reduce the four-performance measure (Income, No of Customer, Overhead Cost and No. of Vehicle) to a latent variable called Success of the Transportation Quality Programme (STQP). The factor was extracted using the principal component method with eigen-values greater than 1 which explains 60.29% of the total variation in performance measures. The tests of Sphericity and Kaiser-Meyers Olkin (Kmo) measure of sampling adequacy validate the adequacy of the use factor analysis (Nunnally 1988).

The SPSS, is also used to reduce the 12 transportation quality practices into a smaller set of four transportation initiatives through principal component methods, which explains 66.78% of the total variations in the transportation quality practices. When the number of factors was increased to five by considering all eigen-values greater than 1, the five factors extracted explained 77.29% of the total variation. The Bartlett test of Sphericity and Kaizer-Mayer Olkin measure of sampling adequacy also indicate the appropriateness of the use of factor analysis.

On rotating the component matrix using varimax method, three quality practices, that is, continuous improvement, employee empowerment and quality training are found to be highly correlated with factor 1. Also three quality practices: benchmarking, customer feedback and customer satisfaction are observed to be highly correlated with factor 2. Moreover, three practices: information, non-monetary reward for quality improvement and management-employee relation are highly correlated with factor 3. Two practices: benchmarking and top management commitment are highly correlated with factor 4, and only one practice: quality team is highly correlated with factor 5. The summary is shown in Table 7.

TABLE 7: SUMMARY OF FACTOR LOADINGS

Factor	% of variance	Scale items	Factor loadings
Q _{p1}	32.51%	Continuous improvement	0.852
		Employee empowerment	0.778
		Quality training	0.594
Q _{p2}	13.22%	Customer satisfaction	0.836
		Benchmarking	0.660
		Customer feedback	0.665
Q _{p3}	12.11%	Information	0.855
		Non-monetary reward	
		For quality improvement	0.699
Q _{p4}	9.79%	Management-employee relation	0.534
		Top management commitment	0.883
		Benchmarking	0.600
Q _{p5}	9.65	Quality team	0.908

The result of factor analysis suggests that transportation quality practices are inter-related and could be grouped into smaller set of quality constructs. These quality constructs are Q_{p1} , Q_{p2} , Q_{p3} , Q_{p4} and Q_{p5} , where

Q_{p1} = Human resources

Q_{p2} = Strategic quality

Q_{p3} = Information

Q_{p4} = Management commitment

Q_{p5} = Quality team

The first and second factors, that is, human resources and strategic initiatives each consists of three practices and explains 32.51% and 13.22% of the total variation respectively. Information initiative consisting of three practices explains 12.11% variation. Management commitment, which has two practices, explains 9.79% of the total variation, while quality team with only one practice explains 9.65% of the total variation.

3.6 FITTING OF REGRESSION MODEL OF SUCCESS OF TRANSPORTATION QUALITY PROGRAMME (STQP) ON THE FIVE QUALITY INITIATIVES

Multiple linear regression was fitted using the single overall performance, STQP, as the dependent variable and the five quality initiatives (Q_{p1} , Q_{p2} , Q_{p3} , Q_{p4} and Q_{p5} , as defined above) as the dependent variables. The result of the fitted model using SPSS package is given by

$$STQP = 0.0328 + 0.024Q_{p1} + 0.218Q_{p2} + 0.525Q_{p3} + 0.047Q_{p4} + 0.220Q_{p5}$$

The model is found to be significant at $\alpha = 0.05$, and the initiatives are found to have positive impact on the Success of the Transportation Quality Programme (STQP) except the Human resources initiative. Though it may not be obvious to interpret the magnitude of the impacts of various initiatives on STQP based on their coefficients, the regression model confirms the research construct that the Success of the Transportation Quality Programme (STQP) is affected by the various initiatives identified.

CONCLUSION

Worldwide, a large percentage of transportation companies are striving to define and implement strategies to improve service product quality. In line with this, research work identified a number of important improvement activities, which include continuous improvement, customer feedback, customer satisfaction, employee empowerment, management-employee relation, and top management commitment among others. These activities should be considered very important for improved transportation service quality and competitiveness.

This research also link the use of these important quality improvement activities to firm success factors which give rise to a well defined structure for quality improvement that if well managed and implemented should result in cost reduction, increase in number of customers and increase in income.

Finally, the research links performance to various improvement activities, enables any firm interested in improving in particular any of the performance measures to consider the activities that are significantly correlated with such performance. (Table 4). It is however important that the transportation firms particularly those included in this study are expected to strive more to improve on human resource initiative consisting of continuous improvement, employee empowerment and quality training.

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