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Analyzing the perceived impact of ISO 9000 Standards on U.S. agribusinesses

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Abstract

We used a non-competitive market framework to assess the perceived impact of ISO 9000 standards on the operational efficiency of registered U.S. agribusiness sites. Kendall Coefficient of Concordance, *W*, was used to rank selected reasons for seeking registration to ISO 9000 standards. The results indicated that registered sites seem to be achieving their goals for registration.

Key words: ISO 9000 Standards, quality management systems, quality assurance, internal benefits

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Introduction

ISO 9000 standards are a series of non-technical, non-prescriptive standards on quality system management (QMS) and quality assurance (QA) that apply to process rather than product standards, with a primary goal is to ensure consistent product quality for registered organizations through third party-audited quality system management and quality assurance activities (Sanders and Scott, 1997). For a registered site, ISO's quality assurance (QA) and quality system management (QMS) activities play complementary roles to achieve internal benefits (Casewell, Bredahl, and Hooker, 1998), which have been associated with improved internal operations (removal of errors), and external benefits that are associated with increased demand for a registered site's product or service, respectively. In this study we focus primarily on the perceptions of quality management representatives of registered agribusiness sites on the impact of these standards on the internal benefits of their sites, and how these relate to the reasons for registering to the standards.

Internal benefits due to registration to one or more model(s) of ISO 9000 series of standards may result from reduced transaction costs through improved product reliability, process control and flow, better documentation of processes, greater employee quality awareness, reductions in product scrap, reworks and rejections, and time required to develop new products and deliver them to the customer at a lower cost of production and

customer-supplier-subcontractor relationships (Hooker et al.; Casewell et al.; Skrabec et al., 1997; Peach, 1997; Mak, et al., 1996).

More than a decade after their introduction, the number of sites that have registered to adhere to ISO 9001, ISO 9002, or ISO 9003 contractual models based on the original ISO 9000 standards of 1987, and revisions of 1994, organizations has soared. ISO 9000 certificates issued worldwide increased by 878% from 27,816 in 1993 to 271,966 in 1998. Those in the U.S. increased by 2,698% from 893 in 1993 to 24,987 in 1998. Although registration to ISO 9000 series of standards by organizations continues to grow globally, debate over its potential and resultant benefits and costs abounds.

The first U.S. agribusiness site registered in 1992, and by 1996, 103 agribusiness sites had registered. Despite the slow initial adoption of these standards by U.S. agribusiness sites, there is evidence of increasing use of QMS and QA activities to manage food quality in an attempt to differentiate products, enhance traceability, better manage waste and risk, and demonstrate compliance with quality standards in response to domestic and global market forces. However, few studies have looked into the reasons for which sites register to these standards, or their impact, if any, on agribusiness firms (Casewell, Bredahl, and Hooker, 1998; Hooker, Ozuna, and Tilburg, 1999). Potential for bias in the few studies conducted so far are heightened because they are written mainly by parties with vested interests, such as consultants and third party auditors (Casewell et al., 1998), in highlighting the successes of the ISO 9000 standards. This study is an attempt to bridge the information gap by studying the reasons and expectations advanced for initiating registration to ISO 9000 standards by U.S. agribusiness sites and matching these with the

goals and perceptions of realized results of registration by quality management representatives.

Objectives

The specific objectives of this study were threefold, to (1) analyze ten selected reasons advanced by quality management representatives of ISO 9000 registered U.S. agribusiness sites for seeking registration to a model of ISO 9000 standards, (2) estimate equations for the reported perceived operational efficiency due to adoption of one or more models of ISO 9000 standards for registered agribusiness sites based on selected QMS indicators, and (3) verify whether registered firms are meeting their reported goals for registration to the standards.

Methods

Empirical Framework

Reasons Given for Seeking Registration to ISO 9000 Standards

We used the Kendall Coefficient of Concordance W , to determine whether quality management representatives (QMR) of U.S. ISO 9000 registered sites showed substantial agreement in their judgement of selected reasons advanced for seeking registration to ISO standards. The hypothesis is that the QMR are in agreement more than what would be expected by pure chance. The Friedman ANOVA test was used to determine whether there were significant differences between the responses by QMR on the reasons advanced for seeking registration to ISO 9000 standards, respectively.

Following Siegel and Castellan (1988), the value of W was then computed as

$$(4.1a) \quad W = \frac{\sum_{i=1}^N (\bar{R}_i - \bar{R})^2}{N(N^2 - 1)/12}, \text{ when corrected for tied ranks becomes}$$

$$(4.1b) \quad W = \frac{12 \sum \bar{R}_i^2 - 3N(N+1)^2}{N(N^2 - 1) - (\sum T_j)/k}$$

where k = Number of respondents (QMR) to the survey (Table 5.1r)

N = i selected reasons advanced for seeking registration to ISO 9000 standards, $i = 1, \dots, 10$.

\bar{R}_i = The average of the ranks assigned to the i th reason advanced for seeking registration to ISO 9000 standards.

\bar{R} = The average (or grand mean) of the ranks assigned across all reasons advanced for seeking registration to ISO 9000 standards.

$N(N^2 - 1)/12$ = The maximum possible sum of squared deviations (the numerator which would occur if there were perfect agreement among the k rankings), and the average rankings were $1, 2, \dots, N$.

$T_j = \sum_{i=1}^{g_j} (t_i^3 - t_i)$ = The correction factor required for the j th set of ranks

t_i = The number of tied ranks in the i th grouping of ties

g_j = The number of groups of ties in the j th set of ranks.

The Kendall coefficient of concordance W , and subsequent Friedman's ANOVA require that the k variables be measured in at least an ordinal scale so that the objects or individuals under study may be ranked in ordered series. Each of the selected reasons in Table 4.3 meets this requirement, because they were measured using a graphic rating scale. To test for the significance of W the quantity,

$$(4.1c) \quad X^2 = k(N - 1)W$$

is approximately distributed as a Chi-square with $N-1$ degrees of freedom. The decision

rule is therefore:

$$(4.1d) \quad \begin{aligned} &\text{If } X^2 \leq \chi^2_{(1-\alpha; k-1)}, \text{ conclude } H_0 : k \text{ sets of rankings are unrelated} \\ &\text{If } X^2 > \chi^2_{(1-\alpha; k-1)}, \text{ conclude } H_a : k \text{ sets of rankings are related} \end{aligned}$$

Following Kutner et al. (1996), the Friedman test statistic was computed automatically by the statistical package, STATISTICA (1995), along with that for Kendall's coefficient of concordance, and reported.

The Potential Effects of Adopting ISO 9000 Standards on Price and Quantity of Products offered by Registered Sites: A Graphical Analysis.

Internal Operational Efficiency

Conceptually the adoption of ISO 9000 standards may, or may not result in gains to a registered organization. First, gains may arise internally to the organization in the area of quality system management through lower transaction and production costs. Lower production costs may arise through fewer nonconforming products, less rework, lowered rejection rates, streamlined processes, and fewer mistakes in general due to adoption of ISO 9000 standards. Lower transaction rates may arise through decreases in auditing, inspection, search fees, laboratory analysis costs, and among other non-traditional (non-financial) quality system management indicators. This area is considered to affect the internal operational efficiency of the organization.

Simple product supply-demand graphical models are developed to analyze relative changes in a firm's cost curves, output levels, and product prices due to each of these scenarios, and a combination of them. This model is similar to the one described by Zaibet and Bredahl (1997) that linked input demand and output to show gains to consumers and

producers resulting from registration to a model of ISO 9000 standards. Zaibet and Bredahl's model assumed that the output market was competitive, input markets are competitive, producers maximize their profits, and all firms are identical before a firm's registration to ISO 9000 standards.

This model differs from Zaibet and Bredahl, in that, it assumes that ISO 9000 registered agribusiness sites operate in output markets that are largely less than (not necessarily) competitive. Therefore sites may have some control over their prices, and undertake actions to try to differentiate their product from the competition, and consequently, influence the direction of output prices. Adoption of ISO 9000 standards would be considered such an act. Therefore, all firms may not be identical before and after registering to one or more ISO 9000 standards. However for simplicity, the model retains the assumption that input markets are competitive, all factors are normal because inferior factors will create ambiguity through resultant increase in average cost and decrease in marginal costs. It is assumed that producers' objective is to minimize cost, a dual of maximizing profits. Straight-line demand and supply curves are used in the subsequent analysis for simplicity.

Figure 1 shows the effect of adoption ISO 9000 standards, in the short run and in the long run, on the price of output and quantity supplied as a result of achieving quality system management goals at the firm level. The first average cost curve (AC_{i0}) represents the average costs incurred by an organization in production before registration to one or more models of ISO 9000 standards, where $i = 1, \dots, T$ is (are) the product line(s) produced by the site. A site may register one or more product lines to one or more

models of ISO 9000 standards. D_i is the short run demand faced by the site before registration to one or more models of ISO 9000 standards. MR_{i0} is the marginal revenue curve for the site before registration. P_{i0} represents the price charged for each Q_{i0} unit of output by the site before registration to ISO, obtained by equating its marginal cost to marginal revenue below its average cost curve.

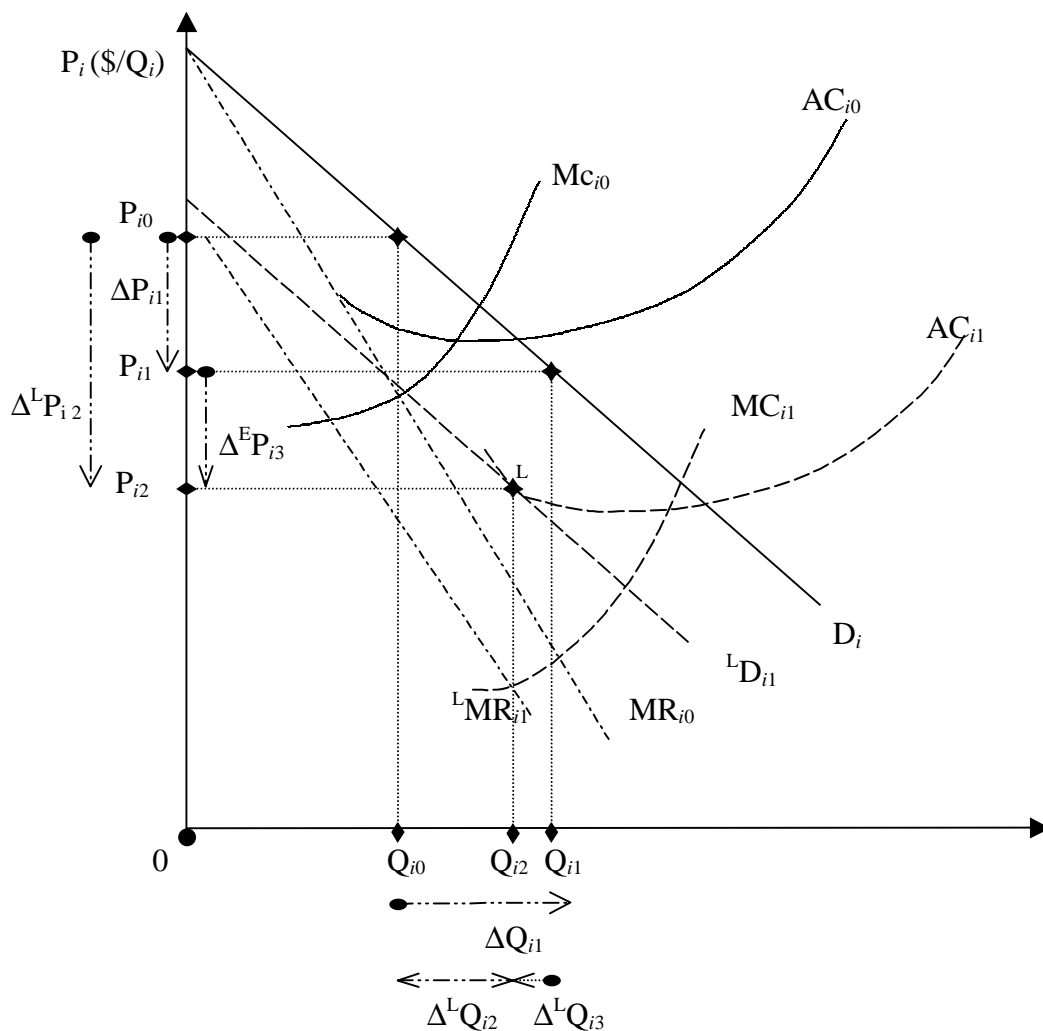


Figure 1. Potential short run and long run^L effect of increased internal operational efficiency on product price and quantity due to adoption of ISO 9000 standards

Figure 1 also shows the second average cost curve (AC_{i1}), which represents the average costs incurred by an organization in production after registering one or more of its product lines to one or more models of ISO 9000 standards. The outward shift to the right is due to production and transaction costs reduced as a result of registration to the quality system management standards. The shift reflects improvement in the operational efficiency of the site due to ISO 9000 standards. D_i remains the short run demand facing the site after registration to one or more models of ISO 9000 standards. MR_{i1} is the marginal revenue curve for the site after registration. P_{i1} represents the price charged for each Q_{i1} unit of output by the site after registration to ISO, obtained by equating its marginal cost to marginal revenue below its average cost curve. The ΔP_{i1} represents the short run reduction in price charged by a registered site due to improved operational efficiency resulting from registering one or more of its product lines to one or more models of ISO 9000 standards. The description above awards ISO 9000 sites economic profits due to registering to ISO 9000 standards in the short run.

However, in the long run, assuming the average cost for an ISO registered site remains same the at AC_{i1} , viable competitors would also register to the ISO 9000 standards to earn some of the economic profits due to gains from the system management gains from adopting standards. The result is, an inward shift to the left of its demand curve to ${}^LDA_{i1}$ due to competition reducing its share of the market for the registered product lines due to increased adoption of ISO 9000 standards in the respective industry. ${}^LMR_{i1}$ is the marginal revenue curve for the site after registration in the long run. P_{i2} represents the price charged for each Q_{i2} unit of output by the site after registration to ISO in the long

run, obtained by equating its marginal cost (${}^L\text{MR}_{i1}$) to marginal revenue below its average cost curve (MC_{i1}).

The $\Delta^E P_{i1}$ represents the long run reduction in price charged by a registered site due to improved operational efficiency resulting from registering one or more of its product lines to one or more models of ISO 9000 standards. The $\Delta^L P_{i1}$ represents the difference in prices, in the long run, charged by a site that adopted ISO 9000 standards and those that did not. The $\Delta^L Q_{i2}$ represents the change in quantity of output as a result of registering to adopting ISO 9000 standards, in the long run. These could be positive or negative, depending on the shapes of the average cost curves, demand curves, and resultant marginal revenue curves. $\Delta^L Q_{i3}$ represents the decrease in quantity of output for a registered site, in the long run due to competitors adopting the ISO 9000 standards.

A Logistic Regression Analysis

The Logistic cumulative distribution function is specified as follows:

$$(4.4a) \quad P_i = \Pr(I_* \leq \mathbf{x}_i' \boldsymbol{\beta}) = \frac{1}{1 + \exp(-\mathbf{x}_i' \boldsymbol{\beta})}, \quad -\infty < \mathbf{x}_i' \boldsymbol{\beta} < \infty$$

$$(4.4b) \quad y_i = \begin{cases} 1 & \text{with probability } P_i \\ 0 & \text{with probability } 1 - P_i \end{cases} \quad i = 1, \dots, T,$$

where

P_i = The probability of a registered site being perceived internally operationally efficient due to registration to one or more models of ISO 9000 standards, ($0 \leq P_i \leq 1$).

y_i = Random dependent variable is one (1) if a registered site is perceived internally operationally efficient but zero (0) otherwise.

- I = A latent index variable, $\mathbf{x}_i' \boldsymbol{\beta}$, linear in $\boldsymbol{\beta}$, and directly related to P_i .
- I_* = A threshold level such that if $I_i \geq I_*$, then y_i is one, but zero otherwise.
- \mathbf{x}_i = A $1 \times K$ vector of observations on a set of quality system management performance indicators (Table 4.3, and Table 4.4).
- $\boldsymbol{\beta}'$ = $(\boldsymbol{\beta}_1, \dots, \boldsymbol{\beta}_k)$ is the parameter vector associated with the quality system management performance indicators, \mathbf{x}_i .

For the Logit model, $P_i = F(\mathbf{x}_i' \boldsymbol{\beta})$, where

$$(4.4c) \quad F(t) = \frac{1}{1 + e^{-t}} \text{ also written as, } \frac{e^t}{1 + e^t}, P_i \text{ and } t \text{ are not linearly related.}$$

The probability of being perceived not internally operationally efficient due to registration to one or more models of ISO standards follows as,

$$(4.4d) \quad (1 - P_i) = \frac{1}{1 + e^t},$$

The odds-ratio in favor of being perceived marketable/ or internally operationally efficient due to registration to a model of ISO 9000 standards follows as

$$(4.4e) \quad \frac{P_i}{1 - P_i} = \frac{1 + e^t}{(1 + e^{-t})} = e^t$$

The fitted logistic response function can be expressed as

$$(4.4f) \quad \overline{F(t)} = \frac{1}{1 + e^{-t}} = [1 + e^{-t}]^{-1}$$

Data

Data on perceptions of quality management representative of registered ISO 9000 agribusiness sites in the United States were obtained through a telephone and mail national survey of registered sites between March and October 1999. Based on careful study of the

two-digit SIC codes, four-digit SIC codes, information and description of SIC codes provided by the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) on SIC codes, and scope of registration as described in the Registered Company Directory, North America, some three hundred and sixty six registered sites were identified as involved in business activities related to agribusiness. The survey used a graphic scale rating to register the perceptions of quality management representatives on (1) ten selected reasons (based on ISO literature) for initiating and implementing ISO 9000 standards, and (2) the impact of ISO 9000 standards on the operational efficiency of their sites. The net response rate representing only usable returned surveys was 32.23 percent of all survey sent to respondents in two mailings. The Chow test was used to verify the absence of overall non-response bias

Results

Reasons for seeking registration to a model of ISO 9000 standards by U.S. registered agribusiness sites

In this study, internal benefits arise through achieving quality system management goals associated with improved internal operations (removal of errors). Table 1 presents a ranking of reasons given by quality management representatives of U.S. agribusiness sites for seeking registration to ISO 9000 standards. The number of respondents was 98 (referred to as $k=98$ in calculating W). The respondents rated (judged) 10 selected reasons (referred to as $N=10$ in calculating W) for seeking registration to the standards. The Kendall coefficient of concordance statistic W was 0.25086. Applying the $X^2 = k(N-1)W$ to determine the significance of this concordance, $X^2 = 221.2585$.

Referring to the table for the Chi square distribution, $\chi^2_{0.001;9} = 27.88$. Therefore it was found that $X^2 = 221.2585$ with nine degrees of freedom has a probability of occurrence under $H_o < 0.001$. It can therefore be concluded that agreement among the 98 respondents is higher than would be by chance had their rankings been random and independent. The very low probability under the null hypothesis associated with the observed value of W enables rejection of the null hypothesis that the respondent's rankings are unrelated to each other. It is concluded that there is a good consensus among the quality management representatives concerning their reasons for seeking registration to ISO 9000 standards.

Results from the Friedman ANOVA test, χ^2_{n-1} , are also reported in Table 1 to be $\chi^2_{(0.00000;9,98)} = 227.9981$. For a level of significance $\alpha = 0.001$, we need $\chi^2_{0.001,9} = 27.88$. Since $\chi^2_{(0.00000;9,98)} = 227.9981 > 27.88$, we reject H_o that the mean rankings for reasons for seeking registration by the quality management representatives are equal, and adopt the H_a , that they are not. Therefore there are highly significant differences between responses on rankings for seeking registration. In addition the quality management representatives surveyed show substantial agreement in their judgment. Based on the average rank, quality management representatives of U.S. ISO 9000- registered agribusiness sites ranked the ten selected reasons as shown in Table 1. The same results would be obtained using the sum of ranks, which represent, from largest to smallest sum, the true ranking of the reasons.

The first ranked reason for seeking registration to ISO 9000 standards was to

improve the sites internal operational efficiency. This is in line with ISO quality system management goals. It is also in accordance with previous studies in other industries that looked into reasons given by firms for seeking ISO 9000 registration (Skrabec, et al.; Zaibet and Bredahl, 1997). The second ranked reason given for seeking registration to ISO 9000 standards was access to new markets. This result is in line with quality assurance goals professed by ISO and in accordance with findings and suggestions that organizations seek to adopt ISO 9000 standards to gain access to new markets, or retain markets (Casewell et al.; Hooker et al. Skrabec et al.; Zaibet and Bredahl, 1997).

Table 1. Ranks of reasons given by U.S. agribusiness sites for seeking registration to a model of ISO 9000 standards.

Selected reason for adopting ISO 9000 standards	Abbreviation	Average Rank	Sum of Ranks	Standard Deviation
Improved operational efficiency	RIOE	7.78	762.00	2.45
Access to new markets	RANM	7.02	688.00	2.58
Site's customer requirement	RCUR	6.58	645.00	3.11
Greater international market share	RGIS	5.96	584.00	2.97
A reduction in costs	RREC	5.95	583.50	2.49
Greater domestic market share	RGDS	5.91	579.00	2.78
European Union (EU) regulations and requirements	REUR	4.61	452.00	3.28
Requirements of regulations other than European Union regulations	ROTR	4.58	448.50	2.82
A reduction in the firms liability	RREL	3.44	337.50	2.28
Site's Supplier requirement	RSUR	3.17	310.50	2.53
ANOVA Chi Square (N=98, DF=9) = 227.9981, $p < 0.00000$				
Coefficient of Concordance = 0.2585				
Average rank $r = 0.25086$				

Some ISO 9000 registered customers require their suppliers to adopt ISO 9000 standards. Suppliers that do not do so might lose out on large contracts (McTeer and Dale, 1996). Johnson (1998) suggested that customers who require suppliers to register

to ISO standards 9000 make their own conformance needs easier to achieve, and improve their internal operational efficiency, a major driving force behind ISO 9000 registration. Quality management representatives in this study ranked customer requirement third for seeking registration to ISO 9000 standards.

The fourth ranked reason for seeking registration to ISO 9000 standards was to reduce the site's costs. Again, this would be directly related to the first ranked reason; improve the sites internal operational efficiency. This result is in line with ISO's quality system management goals. Likewise, the fifth and sixth ranked reasons for seeking registration to ISO 9000 standards were in line with ISO's quality assurance goals of attesting to the presence of a quality system to access markets. They were the fifth ranked reason, registration to gain greater international market share, and the sixth ranked reason, registration to gain greater domestic market share. Three findings are here noteworthy. First, the ranking of greater market share reasons after cost reduction reasons may reassert internal operational efficiency reasons over marketability reasons for seeking registration to ISO 9000 standards. Second, both quality system management goals and quality assurance goals are ranked high relative to other reasons. Last but not least, ISO's primary goal is to facilitate international trade. Respondents ranked greater international market share higher than they did greater domestic share as a reason to become registered to ISO 9000 standards.

Although early publicity ranked doing business in Europe very highly as a reason for which to seek registration to ISO 9000 standards, the initial belief that adoption of ISO 9000 standards would become a required prerequisite to doing business in Europe has not

materialized. The findings of this study ranked European Union requirements and regulations seventh and other non-European Union requirement was ranked eighth. This result may support ISO standards' claim to be a voluntary process, and were not considered important to meet regulatory needs at home and abroad.

Registration to ISO 9000 standards has been suggested to potentially mitigate liability concerns, especially for European markets (Zaibet and Bredahl, 1997). Seeking registration to ISO 9000 standards to reduce liability was ranked ninth by quality management representatives of U.S. agribusiness sites. This result indicates that the representatives did not consider reducing liability an important reason for seeking registration. Further, this result may attest to the lack of regulatory impetus to registration to the ISO 9000 standards. A priori, in contractual situations, suppliers do not require registration for customers. Rather, it is expected that a customer do so to a supplier, and/or a supplier do so for the subcontractor. Similarly to Hooker et al (1999) the quality management representative ranked supplier requirement that a customer be registered last, or tenth, as a reason for seeking registration to ISO 9000 standards.

Logistic Regression Analysis Results

Theory suggests that improved operational efficiency at the firm level results in decreased average costs of conducting business, other things held constant. Equilibrium short-run quantity would increase and product prices decrease.

While the $-2LL$ for present model was 19.33, that for the regression model with the intercept term only was 33.16. The Chi-square tests the null hypothesis that the coefficients for all terms in the current model, except the constant term, are 0. The

calculated Chi-square value for the present model was 13.83. The tabular value for $\chi^2_{0.99;7} = 18.48$. Comparing the two values, since $\chi^2 = 13.83 \leq 18.48$, it was concluded that the logistic response function is appropriate. This result suggests that internal operational efficiency, as perceived by quality management representatives of U.S. ISO 9000 registered agribusiness sites to be related to some combination of the selected quality system management indicators and related variables included in the present model. Given the current model, 80 out of 88 cases or 91 percent of cases were correctly predicted, and classified. A review of parameter estimates, standard errors, odds-ratios, and elasticities at means are presented in Table 2. The results showed that whether a site registered one or more product lines (SCA), and changes in scrap and rework expenses (RWK) were not significantly related to internal operational efficiency at $p < 0.1$. This result occurred for the conservative two-tail t-test.

Results for this model show expected significant relationships between the dependent variable, internal operational efficiency, and the following explanatory variables: log of number of employees at the registered site (LEMP), perceived total sales (TOS), documentation of quality system (DOC), and sites that encouraged suppliers to adopt ISO standards (ECO). A priori, parameter estimates for the log of the number of employees at the site (LEMP) and the level of inventory are expected to be negative. The parameter estimates for changes in total sales (TOS), documentation of the quality system (DOC), and whether or not a site encouraged suppliers to adopt ISO 9000 standards (ECO) are expected to be positive. LEMP was significantly related to internal operational efficiency at $p < 0.1$, TOS at $p < 0.01$, NVE at $p < 0.05$, DOC at $p < 0.01$, and ECO at $p <$

0.05. A discussion of the specific results (Table 2) for each statistically significant result follows.

Table 2. Factors perceived to influence internal operational efficiency of U.S. ISO 9000 registered agribusiness sites

Variable	Logit Model		
	Odds Ratio	Estimated Coefficient ¹ (S.E)	Elasticity at Means
Log of Employees at registered site (LEMP)	0.512	-0.669* (0.370)	-0.05347
> 1 registered product line ^d (SCM)	4.744	1.557 (1.334)	0.01996
^c Total sales ^g (TOS)	4.525	1.510*** (0.640)	0.01995
^c Level of inventory ^g (NVE)	0.293	-1.229** (0.577)	-0.00002
^c Scrap and rework expenses ^g (RWK)	0.579	-0.547 (0.430)	-0.00035
^c Domestic product prices ^g (PPD)	2.571	0.944 (0.851)	0.00267
^c Documentation ^g (DOC)	4.038	1.396*** (0.504)	0.06380
Encourage supplier reg.- ISO ^d (ECO)	13.790	2.624** (1.280)	0.01932
Intercept term	0.558	-0.583 (1.654)	-0.00880
-2Log Likelihood (present model)	19.326	-	-
-2Log Likelihood (intercept term)	33.156	-	-
Likelihood Ratio Test	27.660	-	-

¹Numbers in parenthesis represent Standard Errors (S.E) for corresponding coefficients.
*, **, & *** indicates significance at $p < 0.1$, $p < 0.05$; and $p < 0.01$ levels, respectively

^a Abbreviation for the selected variable.

^c Change in the indicated variable due to registration to a model of ISO 9000 standards

^d Dummy variable

^g Variable measured using graphic scale rating.

^q Quality management representative drawn from the Department of Quality Control

First, internal operational efficiency due to adoption of ISO 9000 standards was inversely related to the log of number of employees at the ISO registered site. Results from the current model indicate the odds of being perceived internally efficient due to adoption of ISO 9000 standards decreased by 0.512, if the log of number of employees at a registered site increased by one. The elasticity at means gives the percentage change in the probability of being perceived internally operationally efficient due to adoption of ISO 9000 standards as a result of a percentage change, at the mean value, in the explanatory variable. Since the elasticity is different for every observation, it is often reported at the mean value of the explanatory variable (SHAZAM, 1997). In terms of elasticity at means, the probability of being perceived internally efficient due to adoption of ISO 9000 standards decreased by about 0.053 percent with a percentage increase in LSEMP. The number of employees could be used as a measure of size of a firm/site (McTeer and Dale, 1996). This finding suggests that smaller sites were perceived to be more internally efficient due to adoption of ISO 9000 standards, which like marketability, could work to their advantage in the market place.

A priori, depending on the market structure a firm would be able to offer more output at the same price or a reduced price due to an increase in its supply. Results for the present model reveals that a unit increase in total sales increased the odds by 4.525 that a registered site was perceived to be internally efficient due to registration to a model of ISO 9000 standards. Therefore the probability of being perceived internally efficient due to adoption of ISO 9000 standards increased by about 0.020 percent with a percentage increase in perceived total sales for ISO 9000-registered agribusiness sites.

In the short run, supply determinants that negatively impact internal operational efficiency increase average costs, thereby decreasing supply of the product. Holding excess inventory may carry costs that could be categorized as variable and fixed. In the short run holding of excess inventory could impact a firm's internal operational efficiency negatively thereby decreasing supply. Results for the current model show that an increase in perceived levels of inventory by 1 unit decreased the odds by 0.293 that a registered site was perceived to be internally efficient due to registration to a model of ISO 9000 standards. Based on the elasticity of means, the probability of being perceived internally efficient due to adoption of ISO 9000 standards decreased by 0.00002 percent with a percentage increase in perceived levels of inventory.

Documentation may also be one of the most difficult processes in implementing ISO 9000 standards (Peach, 1997). However as pointed out above, non-trivial documentation is expected to aid the quality process. The results of this indicate that a unit increase in documentation of the quality system increased the odds by 4.038 that a registered site was perceived to be internally efficient due to registration to a model of ISO 9000 standards. Based on the elasticity at means the probability of being perceived internally efficient due to adoption of ISO 9000 standards increased by 0.064 percent with a percentage increase in the level of documentation for U.S. ISO 9000-registered agribusiness sites. The finding supports the argument that adequate documentation of the quality system improves the performance of a registered site.

Subsection 4.6.4.2 of ISO 9001 system elements affords a customer the right to verify the premises of both the supplier and subcontractor conforms to specified

requirements. If carried to the letter, this can be a costly and time-consuming process. It is a component that creates a quality network that extends beyond the facility's precincts. According to Johnson (1998) this element encourages suppliers to maintain a close working relationship with their subcontractors, create and put into use channels of communication and feedback. Results for this study reveal that sites that encouraged their suppliers to register to ISO 9000 standards increased the odds by 13.79 that their site would be perceived to be internally efficient. Thus the probability of being perceived internally efficient due to adoption of ISO 9000 standards increased by 0.019 percent for registered sites that encouraged their suppliers to adopt ISO 9000 standards.

Conclusions

Few studies have looked into the reasons for which sites register to these standards, or their impact, if any, on agribusiness firms. We analyzed ten selected reasons advanced by quality management representatives of ISO 9000 registered U.S. agribusiness sites for seeking registration to a model of ISO 9000 standards, estimated equations for the reported perceived operational efficiency due to adoption of one or more models of ISO 9000 standards for registered agribusiness sites based on selected QA and QMS indicators, respectively, and verify whether registered firms are meeting their reported goals for registration to the standards. Data on perceptions of quality management representative of registered ISO 9000 agribusiness sites in the United States were obtained through a telephone and mail national survey of registered sites between March and October 1999.

A ranking of selected reasons for seeking registration to ISO 9000 standards are in conformance with quality system management goals, as well as quality assurance goals. Based on Kendall coefficient of concordance W , there was a good consensus among quality management representatives concerning their ranking of reasons for adopting ISO 9000 standards. The highest ranked reason for adopting ISO 9000 standards was to attain greater internal operational efficiency. This is a quality system management activity. The second ranked reason for registration was for greater access to new markets, a quality assurance goal. The third ranked reason was customer requirement, which is related effort to enhance customer satisfaction. Fifth and sixth ranked were greater international market share and greater domestic market share, respectively. European Union regulations and requirements were next, followed by non-European Union requirements. Ninth ranked was using the standards to mitigate liability concerns. As expected, the last ranked reason was supplier requirement that customers register to ISO 9000 standards.

Results for logistic regression used to estimate perceived internal operational efficiency led to the conclusion that the logistic response function is appropriate. The results suggest a relationship between perceived marketability and some combination of the selected quality system management indicators and related variables included in the present model. Eighty, out of 88 cases or 91 percent of cases were correctly predicted, and classified. Results for the logistic regression model show expected significant relationship between the dependent variable, internal operational efficiency, and each of the following explanatory variables. A priori, parameter estimates for the log of the number of employees at the site (LEMP) and the level of inventory are expected to be

negative. This was found to be the case. It would be expected that larger registered sites, represented by a large number of employees, would have larger quality system with more demanding procedural and management needs. The parameter estimates for changes in total sales (TOS), level of documentation of the quality system (DOC), and whether or not a site encouraged suppliers to adopt ISO 9000 standards (ECO) are expected to be positive. This was also found to be the case. ISO registered agribusiness sites might be well advised to encourage their suppliers to register to ISO 9000 standards to achieve quality system management goals.

A priori, improved internal efficiency due to adoption of ISO 9000 would increase supply or shift outward the supply curve of the registered site. An improvement in internal operational efficiency is directly related to output, and inversely related to price, all else held constant. Although perceived domestic product price had a positive sign, it was not statistically significant and does not therefore merit discussion.

Implications

This study evaluated, ex post, the impact of ISO 9000 standards on U.S. registered agribusiness sites based on perceptions of quality management representatives of registered sites. The findings will help agribusiness sites considering registration to one or more models of ISO 9000 standards. The results ranked selected reasons for which sites registered to ISO 9000 standards. Agribusiness managers may compare the rankings of their own reasons with those from the present model. The results also showed gains in internal operational efficiency due to adoption of ISO 9000 standards for registered U.S. agribusiness sites.

Limitations and Suggestions for Future Research

The assumption made that agribusiness sites were similar and could be studied as a group limited the results and conclusions of this study. Agribusiness varies widely. More incisive research targeting specific sectors or sub-sectors within U.S. agribusiness would be illuminating. There is also a need to explore other surveying techniques in order to improve the response rate.

This study relied on perceptions of changes in selected variables rather than on the variables themselves. Future research should consider obtaining measures of the actual variables such as actual sales volumes and product prices due to adoption of ISO 9000 standards. Also research comparing agribusiness and non-agribusiness sites on the basis of selected performance indicators, and reasons for registration may be enlightening.

There was limited response to questions regarding traditional financial measures. This along with the fact that many registered sites had no financial system in place to help measure financial performance due to ISO 9000 standards greatly limits the robustness with which the results and conclusions can be interpreted. Future research may need to use the case study approach in order to obtain access to traditional financial information with which to evaluate performance of registered sites due to adoption of ISO 9000 standards. It might also serve future research well to obtain time series or panel data in order to gauge change in performance due to adoption of ISO 9000 standards over time. Finally, research clearly delineating customers from suppliers, and subcontractors, their roles and relationships, is needed to better understand the inter-relationships within the supply chain of ISO 9000 registered sites.

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