TQM AS A STRATEGY FOR WASTE MINIMIZATION

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Keyword: Environmental, Management, TQM, Quality, Waste

Abstract

Currently, many printing companies are busy implementing total quality management (TQM) practices while trying to keep up with rapidly changing environmental regulations. Yet, very few companies realize that the twin issues of TQM and environmental compliance are directly connected. In fact, the methods for management and improvement that comprise TQM can provide the printer with very effective strategies for achieving conformance to environmental requirements. This paper will clarify the TQM/environmental compliance relationship by demonstrating the influence that waste minimization can have on competitiveness and profitability. Core TQM practices such as cost of poor quality and poor quality prevention planning will be used to address environmental concerns. Specifically, a field survey of plate-related cost of poor quality will be conducted. The analyses will show that (1) TQM is profitable when it is focused on defect prevention, especially when the prevention efforts are taken as far "upstream" in the processes as possible, and (2) when plate failures are reduced, wastes as well as pollution in the printing plant are also minimized and prevented.

Introduction

There are many management misconceptions regarding environmental compliance 1: (1) The environment is not our concern—the word environment conjures up images of expensive end-of-pipe treatment and disposal that add no value but drains profit. These objections are similar to managers who have said that quality costs more than it is worth;

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(2) Environment and quality are two unrelated issues; (3) Management believes achieving environmental compliance is in conflict with the company goals; and (4) Management is unaware of the multi-faceted benefits of maintaining environmental compliance to the company. Therefore, this paper is set out to demystify the relationship between TQM and environmental compliance.

TQM and Environmental Issues

It is the premise of this paper that the methods for management and improvement that comprise TQM can provide the printer with effective strategies for achieving compliance with environmental requirements. TQM focuses on continuous quality improvement in strategic areas of business, e.g., waste minimization. This perspective will allow the management to aim toward accumulating benefits of solving many environmental compliance problems, rather than trying to tackle the problem in one attempt.

Dr. W. Edwards Deming's 14 Points for Management provide an excellent starting point to link quality management ideas with environmental issues. Seven of his points are reviewed below:

- Deming's first point is "Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs." Here, constancy of purpose of an organization is to stay in business. In recent years, many printing companies identified environmental concerns as an important issue to their customers. Some printers even include environmental responsibility in their company's mission statements.

- Deming's second point is "Adopt the new philosophy. We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change." Management must realize the degree to which itself needs to be changed, and learn the role of management in providing leadership for change. In fact, the rapid changes in the realm of environmental compliance require the management to demonstrate flexibility and determination to cope with these changes.

- Deming's third point is "Cease dependence on inspection to achieve quality." Environmentally speaking, this could be related as to cease dependence on the use of certain chemicals to achieve print quality or to get better results on the wash up of rollers, blankets, and plates.

- Deming's fifth point is "Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decreases costs." In other words, a company that only know how to manage defects instead of preventing defects is not competitive.

- Deming's sixth point is "Institute training on the job." The ever changing environmental regulations and subsequent compliance requirements demand the attention of the management as well as all employees involved. Everybody must learn how to handle specific environmentally related tasks, such as hazardous waste minimization and volatile organic compound emission reduction.

- Deming's seventh point is "Institute leadership." The aim of supervisor should be to help employee and equipment to do a better job. The measure of effective leadership is the degree of teamwork achieved, not number of orders given or people assigned to tasks.

- Deming's fourteenth point is "Put everyone in the company to work to accomplish the transformation. The transformation is everybody's job." It is everyone in the company who provides the infrastructure to effect the transformation. In other words, in order to achieve total environmental compliance, everyone must contribute his or her share of effort.

Waste and Waste Minimization

Figure 1 illustrates a generic work flow that is common in many print production processes. In a sense, a printer performs many value-added operations from artwork creation to prepress to press and bindery. An important justification for value-added operations is that the product meets customer's requirements. Else, non-conforming products become wastes that add only cost and drain company profit.

Waste should be defined as any raw material, equipment, manpower, utilities which are not utilized effectively and efficiently towards goods/products produced. This is especially true for the printing operation due to its unique characteristics on waste generation during production. It may explain partially why the average of the estimated cost of waste in the printing and packaging industry is 20% of its total goods and services sold. This huge sum is often hidden in the ambiguous heading of manufacturing costs and often overlooked and neglected by the management. In order to minimize the cost of waste, an integrated approach to waste minimization, i.e., taking the entire printing operation from design to product as a whole and looking through from the total quality management point of view, must be taken by the management.
To relate the above data to the senior management of a company in a meaningful way, it is imperative that the data be expressed in financial terms. Thus, a set of values was selected to describe costs of new materials such as paper, plates, and the costs when these materials were hauled away as waste. The cost of press by the hour is also included. The following cost matrix is used in the study:

<table>
<thead>
<tr>
<th></th>
<th>New (lb.)</th>
<th>Waste (lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>$0.65</td>
<td>$0.0125</td>
</tr>
<tr>
<td>Plate &amp; proc.</td>
<td>$60.00</td>
<td>$0.33</td>
</tr>
<tr>
<td>Average press down-time due to a plate remake (hour)</td>
<td>0.50</td>
<td>Notes:</td>
</tr>
<tr>
<td>Press charge</td>
<td>$500.00</td>
<td>$5/ton</td>
</tr>
</tbody>
</table>

Cost of Poor Quality Estimation

Tracking cost of poor quality provides a realistic way of determining the current state of a company, and gauging the contribution of TQM efforts to company profitability. In this paper, we will provide three scenarios to describe how a company could benefit from its TQM efforts: (1) Scenario A represents cost of poor quality as reported from field data, (2) Scenario B portrays the effect of tightening the appraisal (or inspection) effort, and (3) Scenario C projects a higher level of quality system attainment through problem-solving and defect prevention. The following formulas are used in scenario A:

a) \% plate remake = (plate remake / plate made) x 100.

b) Plate failure costs = (cost of plate and processing chemistry per plate times the number of plate remakes) - (income from plates wasted or scraped). As illustrated in the above cost matrix, the cost of making a plate is $60; the weight of a scraped plate is one-half pound, and one pound of plate, sold as scrap, is worth 33 cents.

c) \% paper waste = (paper wasted / paper purchased) x 100.

d) Press down-time costs = (press charge per hour) x (total press down-time).

e) Paper failure costs = [(price of paper (new) per pound) x (amount of paper wasted)] - [(price of paper (wasted)) x (amount of paper wasted)].

There are two prices for waste paper, i.e., white waste and printed waste. For computational simplicity, it is assumed that waste paper is made up of 90% printed waste and 10% white waste.
f) Plate and press room (or total) failure costs = (plate failure costs) +
         (press down-time costs) + (paper failure costs).

g) Total failure costs as % of annual sales = (total failure costs / annual
         sales) x 100.

Scenario B represents what happens when inspection or appraisal efforts are
increased in the platemaking area. The following assumptions are used: (1)
Since defective plates were detected in the plate room instead of the press
room, the number of plate remakes is considered to be the same as scenario
A; (2) Press down-time and paper waste are reduced by one-half of that in
scenario A. This is how cost of poor quality is calculated in scenario B.

Scenario C represents what could happen when all areas of the
manufacturing process are improved towards defect prevention. This will
lead to fewer plate remakes and less press down-time and paper waste. For
this scenario, the assumptions are that (1) The number of plate remakes is
reduced to one-half of scenario A; (2) The press down-time and paper waste
are reduced by one-half of scenario B.

Data Analysis—Competitive Benchmarking

The data, shown in Table 1, were analyzed using a spreadsheet program
and the methodology described. A quick comparison of cost of poor quality
profile of the three companies for scenario A is shown below:

Table 3. Cost of poor quality data as reported—Scenario A.

<table>
<thead>
<tr>
<th>Company</th>
<th>% Plate remake</th>
<th>Plate failure cost ($)</th>
<th>% Paper waste</th>
<th>Paper failure cost ($)</th>
<th>Press down-time cost ($)</th>
<th>Total failure as % of sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>4.48%</td>
<td>$121,585</td>
<td>39.04%</td>
<td>$7,571,808</td>
<td>$5,080,000</td>
<td>32.81%</td>
</tr>
<tr>
<td>#2</td>
<td>6.94%</td>
<td>$143,365</td>
<td>17.96%</td>
<td>$999,877</td>
<td>$599,000</td>
<td>8.71%</td>
</tr>
<tr>
<td>#3</td>
<td>8.32%</td>
<td>$43,919</td>
<td>10.01%</td>
<td>$89,605</td>
<td>$183,500</td>
<td>3.17%</td>
</tr>
</tbody>
</table>

Table 3, in conjunction with Table 1, reveals many insights into the
competitive benchmarking of a company. Here, we see that (1) Company
#1 has a low plate failure rate of 4.48%, but a high paper waste rate of
39.04%, which contributes to high failure costs, or 32.81% of its annual
sales; (2) Company #2 had its share of poor quality costs as indicated.
Noticed the highest cost category is not plate, but press down-time which
was resulted from a large number of bad plates; (3) Company #3 has a high
plate remake rate of 8.32%, but with a relatively low paper waste rate of
10.01%. It has the lowest total failure cost, or 3.17% among the three
companies compared.

Like a report card, the cost of poor quality study provides a method of
assessing the overall effectiveness of the quality system of a company. By
comparing a company’s cost of poor quality performance with its chief
market rivals, competitive benchmarking allows participating companies to
identify performance gaps in relation to its competitors. Together, they
provide a means of identifying improvement goals and action priorities.

TQM as a Strategy for Waste Minimization

A basic TQM principle is that quality products result from quality systems,
processes, and methods. Further, an organization achieves quality by
mastering the methods of quality measurement and company-wide
continuous improvement. Let’s assume that company #1 is convinced that
there are opportunities to improve its company profit by improving its
quality system. The strategy for reducing poor quality costs in a printing
operation is to (1) Stop defective plates from going into the press room by
detecting them early, and (2) Increase defect prevention efforts by
eliminating the platemaking area. The strategy is illustrated by scenarios B and C as
shown below for company #1. Similar analyses for scenarios #2 and #3 are
included in the Appendix.

Table 4. Waste minimization—from defect detection to prevention.

<table>
<thead>
<tr>
<th>Company</th>
<th>Plates made (lbs.)</th>
<th>Plate remake (lbs.)</th>
<th>% Plate remake</th>
<th>Plate failure cost ($)</th>
<th>Press downtime (hr.)</th>
<th>Press downtime cost ($)</th>
<th>PP failure cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22,702</td>
<td>1,016</td>
<td>4.48%</td>
<td>$121,585</td>
<td>1,016</td>
<td>$508,000</td>
<td>$629,585</td>
</tr>
<tr>
<td>B</td>
<td>22,702</td>
<td>1,016</td>
<td>4.48%</td>
<td>$121,585</td>
<td>508</td>
<td>$254,000</td>
<td>$375,583</td>
</tr>
<tr>
<td>C</td>
<td>22,702</td>
<td>508</td>
<td>2.26%</td>
<td>$60,705</td>
<td>254</td>
<td>$127,000</td>
<td>$187,705</td>
</tr>
</tbody>
</table>

Notice that scenario B focuses on plate inspection, i.e., increased plate
inspection will not reduce the plate remake rate, but it will reduce the press
down-time and paper waste. Scenario C represents increased prevention
efforts in the platemaking operation. Prevention efforts are focused on root
cause removal. This will lead to further reduction in plate remake and paper
waste.

Many statistical quality control (SPC) techniques are useful when systematic
process analysis and improvement are addressed through company-wide
employee involvement. Figure 2 shows a cause-and-effect diagram that
helps identify possible causes of plate remakes.
Discussion and Conclusion

Waste minimization audit and cost of poor quality study offer insight into where waste exists, how it can be minimized, and how company profitability can be increased. It provides a method of assessing the overall effectiveness of the quality program over time.

We analyzed cost of poor quality data from three printing companies. We were enlightened by the benchmarking findings of the three commercial printing companies. Once a company learns its poor quality costs, it is difficult for the management simply to ignore the competitive nature of its operations and to go on with its business as usual. Different scenarios of the cost of poor quality analyses show the potential contribution of increased inspection and defect prevention to company profit.

Although costs of inspection and prevention are not specified in this study, the savings from reduced failure costs, as shown in the figure below, should cover the cost of inspection and prevention costs so long as the total quality cost is minimized (indicated by the left-hand side of the total quality costs curve).

The analysis of these case studies show TQM is profitable when it is focused on defect prevention, especially when the prevention efforts are taken as far upstream in the process as possible. When plate failures are reduced, waste as well as pollution in the printing plant are also minimized and prevented. This is why Dr. Deming's on "cease dependence on inspection to achieve quality" is so revealing.

An organization can approach pollution prevention and waste minimization in the same manner as it approaches total quality management 6, i.e.,(1)
Identify sources of waste and select those with the greatest impact; (2) Investigate and evaluate options that will eliminate or greatly reduce the waste; (3) Decide what changes in the process will deliver quality products at a reasonable cost and, at the same time, prevent waste that is detrimental to the workplace and community; and (4) Train employees to be waste conscious and handle machinery and material correctly. Thus, the impact of TQM, as exemplified by the cost of poor quality and defect prevention measures, not only improves quality and productivity, but also fulfills environmental conformance.

Acknowledgment

The authors wish to extend their sincere appreciation to those printing companies who generously shared cost of poor quality data. Without their help, it would not have been possible to complete this work and to obtain the competitive benchmarking findings that are so informative in this study.

References

1. “Environmental TQM”, by Philip Green, Quality Progress, May 1993, pp. 77-80.

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Appendix.

Waste Minimization Analyses for Company #2 and #3.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>(2) Plates made (lbs.)</th>
<th>(3) Plate remake (lbs.)</th>
<th>(5)(2) % Plate remake</th>
<th>(6) Plate failure cost ($)</th>
<th>(7) Press downtime cost ($)</th>
<th>(8)(6)+(7) TF failure cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>17,267</td>
<td>1,198</td>
<td>6.94%</td>
<td>$143,365</td>
<td>1,198</td>
<td>$599,000</td>
</tr>
<tr>
<td>B</td>
<td>17,267</td>
<td>1,198</td>
<td>6.94%</td>
<td>$143,365</td>
<td>999</td>
<td>$299,500</td>
</tr>
<tr>
<td>C</td>
<td>17,267</td>
<td>999</td>
<td>5.47%</td>
<td>$71,682</td>
<td>300</td>
<td>$149,750</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario</th>
<th>(4) Paper pcs/hd (lbs.)</th>
<th>(5) Paper wasted (lbs.)</th>
<th>(5)(4) % Paper waste</th>
<th>(9) Paper waste cost ($)</th>
<th>(10)(6)(9) Total failure cost ($)</th>
<th>Failure as % annual sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8,610,000</td>
<td>1,546,600</td>
<td>17.96%</td>
<td>$999,877</td>
<td>$1,724,242</td>
<td>8.71%</td>
</tr>
<tr>
<td>B</td>
<td>8,610,000</td>
<td>773,300</td>
<td>8.98%</td>
<td>$442,938</td>
<td>$942,803</td>
<td>4.71%</td>
</tr>
<tr>
<td>C</td>
<td>8,610,000</td>
<td>386,650</td>
<td>4.49%</td>
<td>$249,969</td>
<td>$471,402</td>
<td>2.36%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario</th>
<th>(2) Plates made (lbs.)</th>
<th>(3) Plate remake (lbs.)</th>
<th>(5)(2) % Plate remake</th>
<th>(6) Plate failure cost ($)</th>
<th>(7) Press downtime cost ($)</th>
<th>(8)(6)+(7) TF failure cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4,410</td>
<td>367</td>
<td>8.32%</td>
<td>$43,919</td>
<td>367</td>
<td>$183,500</td>
</tr>
<tr>
<td>B</td>
<td>4,410</td>
<td>367</td>
<td>8.32%</td>
<td>$43,919</td>
<td>184</td>
<td>$91,750</td>
</tr>
<tr>
<td>C</td>
<td>4,410</td>
<td>184</td>
<td>4.16%</td>
<td>$21,959</td>
<td>92</td>
<td>$45,875</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Scenario</th>
<th>(4) Paper pcs/hd (lbs.)</th>
<th>(5) Paper wasted (lbs.)</th>
<th>(5)(4) % Paper waste</th>
<th>(9) Paper waste cost ($)</th>
<th>(10)(6)(9) Total failure cost ($)</th>
<th>Failure as % annual sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1,385,000</td>
<td>138,600</td>
<td>10.01%</td>
<td>$89,605</td>
<td>$317,024</td>
<td>3.17%</td>
</tr>
<tr>
<td>B</td>
<td>1,385,000</td>
<td>69,300</td>
<td>5.00%</td>
<td>$44,802</td>
<td>$180,471</td>
<td>1.80%</td>
</tr>
<tr>
<td>C</td>
<td>1,385,000</td>
<td>34,650</td>
<td>2.50%</td>
<td>$22,401</td>
<td>$90,236</td>
<td>0.90%</td>
</tr>
</tbody>
</table>