

Three-Stage Process Cost Model of Total Quality Management Practice in a Decentralized Firm.

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ABSTRACT

In today's tough competitive economy, Total Quality Management (TQM) is one of the management strategies that helps to keep organizations on track. This management philosophy integrates everyone in an organization on the bases of continuous improvement efforts. This approach empowers the managers to lead, communicate, reward, recognize, and make decisions as well as tracks how accurately costs of quality are accounted for and managed on a continuous improvement basis for the satisfaction of both employees and customers. This aim of this paper is to present a three-staged process cost model in a decentralized system firm. The cost model can be compared favorably with the two-stage process formulation but this approach improves on the previous by adding a stage ahead.

(Keywords: quality, TQM, firm, model, organization, decentralized, cost management, competitiveness)

INTRODUCTION

The increasing need for the improvement of quality the world over has led to the development of quality systems to take care of all relevant aspects related to and influencing product quality starting from design and culminating in service to the user. Because of the increase in product complexity and the size of operations, responsibility for product quality has gradually shifted from operator to the quality control department.

Quality is defined as the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs. It is the degree to which a specific product or service conforms to a design or specification. Total Quality Management (TQM) is defined as a

quality-centered, customer-focused, fact-based, team-driven, senior-management-led process to achieve an organization's strategic imperative through continuous process improvement (Abdullahi, 2011).

The objective of this paper is to model a three-stage process cost model as it's relates to TQM in a decentralized firm. It presents organizational benefits of TQM by examining quality decisions within a decentralized firm. Specifically, the study investigates whether quality decisions can be made in a decentralized manner, and if TQM principles can improve firm competitiveness. The researcher assumed a serial production system with a decentralized decision making as obtained in Power Holding Company of Nigeria (PHCN). The basic variables of the model involves, variable cost and customer quality cost functions. The main theoretical field that is used in this paper is the concept of TQM, meanwhile within this field the word quality is central.

TQM Concept

Over three decades ago, researchers such as Crosby (1979), Ishikawa (1985), Saraph *et al.* (1989), Juran and Gryna, (1993), Deming (1994), Flynn *et al.* (1995), and Ahire *et al.* (1996) had developed certain propositions in the field of TQM, which had gained significant acceptance throughout the world. Their insights provided a good understanding of the TQM philosophy, principles, and practices.

From their research, TQM is then defined as: A management philosophy for continuously improving overall business performance based on leadership, supplier quality management, vision and plan statement, evaluation, process control and improvement, product design, quality system improvement, employee participation, recognition and reward, education and training, and customer

focus. Management must keep in mind the TQM way of thinking when managing a company.

Hackman and Wageman (1995) presented that TQM strategy is rooted on four related assumptions:

- (i .) Quality is less costly and essential to long-term organizational survival.
- (ii .) People naturally care about the quality and have instinctive drive for precision, beauty and perfection.
- (iii .) Organizations are systems of interdependent parts and the problem is to face invariably cross-traditional functional lines.
- (iv .) Senior management creates the organizational systems and the employees' work effectiveness is a direct function of the quality of the system.

According to Hackman and Wageman (1995), TQM has both 'hard' and 'soft' sides. However, McKenna and Beech, (2002) and Wilkinson (1999) argued for greater emphasis on the soft aspects of TQM.

The 'hard' side includes methodologies and tools, such as statistical process control (SPC) and the basic quality management tools, respectively. However the 'soft' side of TQM is related to human recourse issues and cultural changes (Wilkinson, 1999).

Sila and Ebrahimpour (2002) found that the following factors were most frequently addressed in the study of TQM and these are referred to as the 'soft' aspect of TQM:

- (i .) Customer focus and satisfaction
- (ii .) Employee training
- (iii .) Leadership and top management commitment
- (iv .) Teamwork
- (v .) Employee involvement
- (vi .) Continuous improvements and innovation
- (vii .) Quality information and performance measurements

Cost of Quality

Cost of quality programs for both manufacturing and service industries, contribute the quality management program by adding assurance from the trust. As a result, the cost of corrective actions can be accepted easily. Cost of quality measurements leads the management like cost accounting system does. To manage the quality more effectively, these measurements define and handle the costs that affected by quality cost program (Kayakutlu and Düzdar, 2006).

Total quality costs for any organization can be related as illustrated in Figure 1. TQM system is a management umbrella gathering many concepts to satisfy the customers and to use the quality improvement tools. TQM approach accelerates the profitability, sales and marketing strategies of the firm. It finds solutions for products that fail inside the warranty period and the failures at after sales services and excessive maintenance costs.

MATERIALS AND METHODS

Lederer and Rhee (1995) formulated a firm's problem to maximize its profit through choice of quality, quality technology for a two-stage process; whereby stage one is dependent on the second-stage process. This idea is used to establish a proposed model for organizational benefits of TQM in a three-stage process, starting from customers cost of quality as:

$$\text{Customers cost of quality} = \lambda \prod_{i=1}^n q_i \quad (1)$$

$$\text{Cost of Technology} = Q \sum_{i=1}^n f_i T_i \quad (2)$$

Variable Production cost for a stage-process =

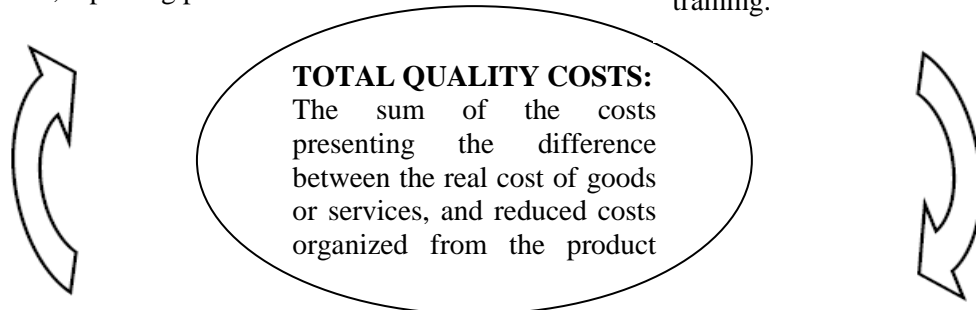
$$\frac{V_i Q^2}{T_i q_i} \quad i=1, 2, 3, \dots, n-1, n \quad (3)$$

EXTERNAL FAILURE COST:

The costs that occurred after delivery of goods. Example: the costs to handle the customer complaints, returned goods, replacing products.

PREVENTION COSTS:

The costs of systems to design the prevention of defects. Example: The costs to review the new product, quality planning, improvement projects, quality training.

**TOTAL QUALITY COSTS:**

The sum of the costs presenting the difference between the real cost of goods or services, and reduced costs organized from the product

INTERNAL FAILURE COSTS:

The costs that occurred before the delivery of goods. Example: scrap, rework, retest and reviewing the material costs.

APPRAISAL COSTS:

Measurement evaluation and inspection costs to fit the quality standards and efficiency situations. These are the input and source review costs in process, final control, purchased material and equipment calibration.

Figure 1: Components for Total Costs of Quality.
(Source: Kayakutlu and Düzdar, 2006)

RESULTS AND DISCUSSION

This research considered PHCN of Nigeria under three-stage process (generation, transmission and distribution). The firm's problem is to maximize its profit through choice of quality, quantity and technology. A generalized firm's problem is formulated as:

$$\text{Max } \Pi = (p - \lambda q_1 q_2 q_3)Q - F - (f_1 T_1 + f_2 T_2 + f_3 T_3)Q - \left(\frac{V_1}{T_1 q_1} + \frac{V_2 q_1}{T_2 q_2} + \frac{V_3 q_1 q_2}{T_3 q_3} \right) Q^2 \quad (4)$$

$q_1, q_2, q_3, Q, T_1, T_2, T_3$

Where,

P = price of goods or service tariff

q_i = Stage quality level

T_i = Choose Technology

Q = Quantity produced

F = Fixed cost

λ = Constant

Then taking partial differentiation of Equation (4) with respect to Q, q_1 , q_2 , q_3 , T_1 , T_2 and T_3 in turn and equating to zero gives the following set of equations:

$$\frac{\partial \Pi}{\partial Q} = p - \lambda q_1 q_2 q_3 - (f_1 T_1 + f_2 T_2 + f_3 T_3) - 2 \left(\frac{V_1}{T_1 q_1} + \frac{V_2 q_1}{T_2 q_2} + \frac{V_3 q_1 q_2}{T_3 q_3} \right) Q \quad (5)$$

$$\frac{\partial \Pi}{\partial q_1} = -\lambda q_2 q_3 Q - \left(-\frac{V_1}{T_1 q_1^2} + \frac{V_2}{T_2 q_2} + \frac{V_3 q_2}{T_3 q_3} \right) Q^2 = 0 \quad (6)$$

$$\frac{\partial \Pi}{\partial q_2} = -\lambda q_1 q_3 Q - \left(-\frac{V_2 q_1}{T_2 q_2^2} + \frac{V_3 q_1}{T_3 q_3} \right) Q^2 = 0 \quad (7)$$

$$\frac{\partial \Pi}{\partial q_3} = -\lambda q_1 q_2 Q + \frac{V_3 Q^2 q_1 q_2}{T_3 q_3^2} = 0 \quad (8)$$

$$\frac{\partial \Pi}{\partial T_1} = -f_1 Q + \frac{V_2 Q^2}{T_1^2 q_1} = 0 \quad (9)$$

$$\frac{\partial \Pi}{\partial T_2} = -f_2 Q + \frac{V_2 Q^2 q_1}{T_2^2 q_2} = 0 \quad (10)$$

$$\frac{\partial \Pi}{\partial T_3} = -f_3 Q + \frac{V_3 Q^2 q_1 q_2}{T_3^2 q_3} = 0 \quad (11)$$

Now analyzing PHCN as a decentralized firm consisting of three processes which could be organized as profit centers or with process 3 (distribution) as a profit centre and process 1 (generation) and 2 (transmission) as a cost centers.

Process 3:

$$\text{Max } \Pi_3 = (p - \lambda q_1 q_2 q_3) Q - \beta Q - f_3 Q T_3 - \frac{V_3 Q^2 q_1 q_2}{T_3 q_3} \quad (12)$$

q_3, Q, T_3

Parameter β is the transfer cost that process 3 is charged for inputs from process 1 and 2, respectively.

Process 2:

$$\text{Min } \Pi_2 = -f_2 Q T_2 - \frac{V_2 Q^2 q_1}{T_2 q_2} \quad (13)$$

q_2, Q, T_2

Process 1:

$$\text{Min} \prod_1 = -f_1 Q T_1 - \frac{V_1 Q^2}{T_1 q_1} \quad (14)$$

q_1, Q, T_1

For simplicity of the analysis Equations (13) and (14) can be combined as a single cost center, thus we have:

$$\text{Min} \prod = -(f_1 T_1 + f_2 T_2) Q - \left(\frac{V_1}{T_1 q_1} + \frac{V_2 q_1}{T_2 q_2} \right) Q^2 + \mu q_1 q_2 \quad (15)$$

$q_1 q_2, Q, T_1 T_2$

Parameter μ is the cost factor for both process 1 and 2 for chosen is technology to achieved a desired output of third-stage.

$$\frac{\partial \Pi}{\partial T_1} = -f_1 Q + \frac{V_1 Q^2}{T_1^2 q_1} = 0 \quad (21)$$

Now taking partial differentiation of Equation (12) with respect to Q , q_3 , and T_3 , give the following equations for the profit center:

$$\frac{\partial \Pi}{\partial T_2} = -f_2 Q + \frac{V_2 Q^2 q_1}{T_2^2 q_2} = 0 \quad (22)$$

$$\frac{\partial \Pi}{\partial Q} = p - \lambda q_1 q_2 q_3 - \beta - f_3 T_3 - \frac{2V_3 Q q_1 q_2}{T_3 q_3} = 0 \quad (16)$$

By comparing Equation (16) with (5) incentives for the profit center can be aligned with those of the firm as a whole if the transfer cost is set at:

$$\frac{\partial \Pi}{\partial q_3} = -\lambda Q q_1 q_2 + \frac{V_3 Q^2 q_1 q_2}{T_3 q_3^2} = 0 \quad (17)$$

$$\beta = \frac{\partial \left(f_1 Q T_1 + f_2 Q T_2 + \frac{V_1 Q^2}{T_1 q_1} + \frac{V_2 Q^2 q_1}{T_2 q_2} \right)}{\partial Q} \quad (23)$$

$$\frac{\partial \Pi}{\partial T_3} = -f_3 Q + \frac{V_3 Q^2 q_1 q_2}{T_3^2 q_3} = 0 \quad (18)$$

which expressed the marginal production cost for the cost centers.

Likewise partial differentiation of Equation (15) with respect to q_1 , q_2 , T_1 and T_2 , give the following equations for the cost center:

Similarly comparing Equations (19) and (6) & (20) and (7) for the cost center can be aligned with those of the firm as a whole if the cost of chosen the technology is set to be:

$$\frac{\partial \Pi}{\partial q_1} = \left(\frac{V_1}{T_1 q_1^2} - \frac{V_2}{T_2 q_2} \right) Q^2 + \mu q_2 = 0 \quad (19)$$

$$\mu_i = \frac{\partial \left(\lambda Q q_1 q_2 q_3 + \frac{V_3 Q^2 q_1 q_2}{T_3 q_3} \right)}{\partial q_i} \quad i=1,2 \quad (24)$$

$$\frac{\partial \Pi}{\partial q_2} = -\frac{V_2 Q^2 q_1}{T_2 q_2^2} + \mu q_1 = 0 \quad (20)$$

Equation (24) expressed the marginal technological cost for the cost centers.

CONCLUSION

This paper relates cost of quality and TQM in a decentralized firm. This research analyzed PHCN as a decentralized firm. The research classified the cost analysis based on the existing three (3) main processes (generation, transmission, and distribution) in the firm. The Model present the interrelation between the cost center and profit center as a result of chosen a technological strategy and quality standard, specially referring to the transfer cost that process 3 is charged for inputs from the previous process and the cost factor for chosen strategy to achieved a desired output of the final stage of production.

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