Cost of Quality Considering the Latent Variable: SMEs Sector of Bangladesh

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Abstract The market domination is shifted from the producer to the customers. They have available alternatives to choose and buy products from the market at competitive price. Hence, defective products (if sold) that dissatisfy the customers, raise external failure costs and hold back the sustainable profit for the organization and consequently the organization is compelled to phase out form the market. This paper has dealt with identifying the factors that are responsible to the defective products basically in the production process. On this basis this paper has tried to develop a model by following a new approach considering the latent variable.

Key Words Value chain; Production process; Opportunity cost; Competitive market; Defective products; Small and medium enterprises

1 Introduction

Quality refers to degree of excellence. However, quality is customer oriented. Joseph Juran (1988) defines quality as fitness for use [1]. Crosby (1979) focuses on defining quality as "conformance to requirements" [2]. From that point quality can be defined as degree to which a product or services satisfy targeted or specific customer wants or the degree to which a product conforms to design specifications and engineering requirement.

Globalization broadens the opportunities for the customer. The boundaries of countries no longer can define the limits of our imagination. The important thing is that customer dissatisfaction should be reduced regarding quality otherwise organization may be compelled to phase out from the market.

2 Methodology

This paper deals with the development of proposition regarding cost of quality through the value chain. Moreover, from the developed proposition, questionnaire has developed to measure the cost of quality, regarding SME sector of Bangladesh based on the Likert's scale. Although, our developed proposition is production process oriented, we have considered preproduction task, production task and postproduction task in our paper.

3 Literature Review

Albright and Roth (1992) define quality costs as quality costs are incurred to ensure that quality standards are met or because quality standards are not met [3]. Researchers have discussed about the cost of quality in different perspective. One famous and well known approach is "The Quality Costing Approach" [4]. This approach is also known as PAF (Prevention-Appraisal-Failure) method (Russell and Taylor 1995; Juran 1998; BSI 1992; Campanella 1999), which consists of four basic elements: Prevention Costs, Appraisal Costs, Internal Failure Costs and External Failure Costs.

3.1 Prevention costs

The costs that incurred in personnel engaged in designing, implementing and maintaining the quality system is called prevention costs. It includes quality planning, quality engineering, quality training programme, quality reporting, supplier evaluation and selection etc.

3.2 Appraisal costs

The costs that incurred in measuring, evaluating, or auditing products, components, and purchased materials to assure conformance with quality standards and performance requirement is known as appraisal costs. It includes pre-production verification, laboratory acceptance testing, incoming inspection and test, in-process inspection and test, final inspection and test etc.

3.3 Internal Failure costs

The costs that incurred when products, components, and materials fail to meet quality requirement prior to transfer of ownership to the customer is known as internal failure costs. It includes scrap, rework and repair, troubleshooting or defect/failure analysis, re-inspection etc.

3.4 External Failure costs

The costs that incurred when the product does not perform satisfactorily after the transfer of ownership to the customer is known as external failure costs. It includes returned material, customer complaints, product liability, warranty claims, loss of sales.

4 Proposition Development through Value Chain

A value chain is a chain of activities for a firm operating in a specific industry. To improve the operational efficiency to improve product quality, many management tool have been suggested and implemented. Porter (1985) in his book "*Competitive advantage"* suggests value chain analysis [5]. According to Porter, Value chain involves with "disaggregating a firm's operations into strategically relevant activities in order to understand the behavior of costs and potential source of differentiation". This understanding of behavior of different activities is essential to improve the quality.

For strategic advantages an organization has to observe the value added activity in the organization. Hence it is necessary to draw a value added activity model of an industry. Manager need to keenly consider the business environment and the firm's position among the local and international competitors before establishing a cost structure and allocating resource to value chain [6]. After drawing a value added activity model a firm can choose his area where he can enjoy strategic advantages to operate business. To enjoy competitive advantages he has to understand the cost drivers and behavior of costs. To do this appropriate analysis of value chain is necessary.

The value chain is a string of activities that gradually add value to the different value drivers of the products to improve the quality. The performance of these value drivers are passively and **positively** related with some fundamental blocks (Porter identified as secondary activity of value chain①) in the organization.

Proposition 1: Behavior of different fundamental blocks or drivers of the organizations force the activity of different components of value chain

Here, fundamental block indicates the drivers that move forward the main component of value chain, primary component as well as secondary component. Primary components include inbound logistics, operations, outbound logistics, marketing and sales and service. Secondary activities include organization infrastructure, human resource management, technology development and procurement. Porter assumed that secondary activities heavily influenced primary actives.

Basically, achieving strategic goals requires linking the daily actions of everyone in an organization to the larger strategic objectives. The Japanese refer to this as *hoshin* planning or "policy deployment" [7].

From these ground we have tried to understand the main driving force of quality. To understand these properly, we have tried to adjust the work of Kaoru Ishikawa. Kaoru Ishikawa, in his book "Introduction to Quality Control" identify five fundamental blocks (manpower, machines, methods, materials and environment) in the firm to improve the product quality on the basis of cases and effects [8].

Manufacturing scenario has totally changed now form the previous. Manufacturing system has heavily mechanized. Organizations are also compelled to produce the customized product to satisfy the customer in the customer dominated market. So, we think Product design is also fundamental blocks that has impact on the value chain. Moreover, scarcity of energy also is raising concern about the continuous service to the customer. So, we have identified utility as a separate block.

Proposition 2: Manpower, Materials, Machines, methods, environment, utility and product design have significant impact on the value chain as well as product quality.

By using the fundamental blocks properly, organizations have to conduct its value chain efficiently to satisfy the customer. The survival of any organization depends on its customers [9]. Robin Cooper uses a three-dimensional space represented by price (cost), quality, and functionality to represent competitive strategy [10]. If the quality of product is good, price is competitive and available when the customer wants, respective firm will enjoy competitive advantage as well as financial growth.

If organization can identify and maintain its value chain by driving fundamental blocks efficiently, it will be able to satisfy its customer regarding quality, time and price.

Proposition 3: Different fundamental blocks of the organization have significant impact on the financial loss function of the organization.

The impacts of different fundamental blocks on the different components of value chain are not the

① Porter identified these as secondary activities, but we have tried to identify more specifically to understand their behavior individually and their impact individually.

same. Particular fundamental blocks have more impact on particular component of value chain then others.

Although it is difficult to explain the impact of particular fundamental blocks on particular component of value chain, but it seems plausible that the impact of fundamental blocks on different component of value chain is not same.

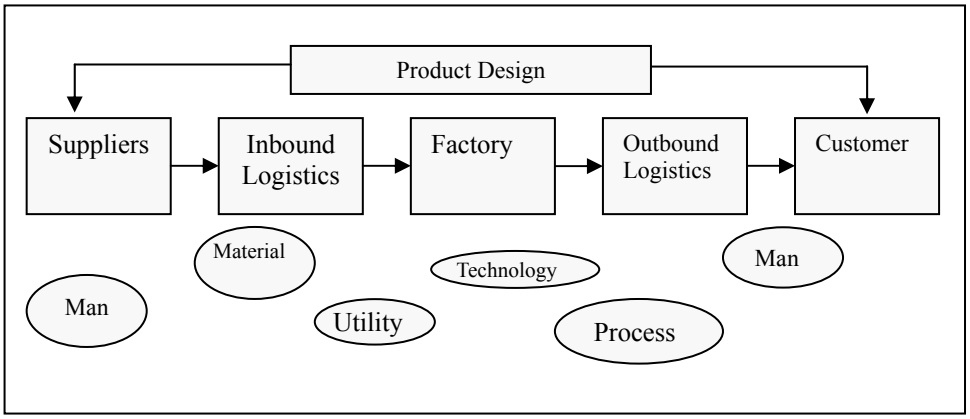

Figure 1 Value Chain with Its Driving Force with the Respective Level

This figure shows that, customer dominated market heavily dominates the product design. If organization fails to understand the customer demand regarding design, external failure costs will raise. The hidden as well as visible costs of these types of failure are so high. In case of hidden costs, costs may increase quadratically as actual product characteristics deviate from a target value [11]. And visible costs are the costs of efforts of all components of value chain.

The costs of man are vague as man is involved with all over the value chain. However, in our research we have assumed the costs of man indicate the labor cots. Because of heavily mechanized production process, firms are incurring the major labor costs before the production process in the value chain. If error is found before production process cased by man, visible costs is efforts have spent up to this portion. As in maximum case, firm check the material before stored at the inbound logistics, so visible costs is efforts spend up to this portion.

Material is the basic input to produce the final products. Every firm checks the material before apply in factory to process with technology or specified process of production. So, if any problem arises in that case, visible costs will be the effort spent up to that potion form the beginning.

Similarly, the defects caused by utility or technology or different level of process required different level of efforts to continue the production.

In figure 1, we have tried to identify the influence power of fundamental blocks on the component of value chain. The closer the fundamental blocks with the component of value chain the higher the influence power.

We think that in case of organizations those are producing homogenous product, it will be very easy to follow the figure 1. We are not considering process costing of accounting where rework is calculated by percentage of task completed, we are considering the process of flow of value added activity in the organization. Hence our next proposition is;

Proposition 4: Different fundamental blocks of production process impacts with different parameter on the cost of quality regarding efforts needed to rework

Organizations are facing heavy competition in the world market. Customers are surrounded by a full of option. Any disturbance or delay in the building blocks to continue the value chain will move it backward as any thing that makes a company deviate from its planned activities incurs opportunity costs [6].

Although traditional accounting don't count opportunity cost as a cost of product, high opportunity cost may cause losing the market in the highly competitive environment.

Weak performance of building blocks may impact in two ways on the financial performance of the organization. Firstly**,** delays in each building blocks will raise the probability of lose of market as market is full of option. Secondly**,** weak performance of building blocks will produce lower finished output then the target, which will increase per unit fixed costs. As a result firm will lose competitiveness regarding

price in the market or profit will be lower. In economics, traditionally it is assumed that production capacity can't be increased in the short run [12]. Hence, following proposition can be drawn,

Proposition 5: Failures of different building blocks in the production process have different opportunity cost based on time to take to rework

We are not considering process costing of accounting where rework is calculated on the basis of homogenous work having done. We are considering the process of flow of value added activity in the organization. So, finally we can draw the last proposition as,

Proposition 6: each fundamental block has significant impact on the financial loss function with at least two latent variables (time and opportunity cost) and one intervening (rework) variable.

5 Survey Result in Bangladesh

5.1 Survey procedure

As the SMEs (Small and Medium Enterprises) assemble on small capital and profit, cost of poor quality seriously affect SMEs. On the basis of our developed proposition we conducted a survey on the basis of Likert scale (5 points scale). For employing our model, we have set components from proposition 2[①]. To raise concern in respondents about the opportunity costs and the value chain, we set three questions for each fundamental block. That indicates, in our questionnaire we have included *true* as well as *latent* variable. To determine the dependent variable we have taken opinion on return on investment (ROI), market share, sales etc that are influenced by fundamental blocks. Survey mainly conducted among manager and finance and control officer of the firm.

5.2 Response rate

Response rate is about 58%. Among 63 questionnaires at 38 firms 39 are collected including 2 uncompleted questionnaires.

5.3 Findings

Defective product designs incur high cost i.e., impact more adversely on the financial loss function. The result of the survey are shown in table 1

Table 1 Multiple Regression Analysis

Variable	Coefficient	Std. Error.	t	p> | t |	Beta
Product Design	.1517	.0590	2.57	.015	.3305
Man	.1419	.0824	1.72	.095	.2097
Material	.1723	.0840	2.05	.049	.2710
Utility	.1117	.0641	1.74	.091	.2143
Technology	.1109	.0628	1.77	.087	.2105
Constant	1.8965	.4021	4.72	.000	-
n = 37, Prob >F=0.0000, R-squared = 0.6093, Adjusted R-squared = 0.5463					

Mathematical model may be expressed as $y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + u$, where y = financial loss function, x_1 =Product design, x_2 =man, x_3 =material, x_4 =utility, x_5 =technology and u =unobserved factors. So we can write

$$y = \alpha + .3305\, x_1 + .2097\, x_2 + .2710\, x_3 + .2143\, x_4 + .2105\, x_5 + u$$

Analysis reveals that product design has the strongest impact (.3305) on the financial loss function with the highest confidence level which is 98.50%. Material is in second position (.2710) with the 95.10% confidence level. Man, utility and technology stands after the product design and material.

The R-squared is 0.6093, meaning that approximately 60.93% of the variability of financial loss is accounted for by the variables in the model. Adjusted R-squared indicates that about 54.63% of the variability of financial loss is accounted for by the model; even after taking into account the number of predictor variables in the model.

6 Future Research

We have conducted our survey in small area. It's a limitation of our analysis. There is a scope of conducting research in specific industry to determine the significant level of the fundamental factor's impact on the financial loss function.

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① We have used technology, methods and process interchangeable, as in SME the differentiation of these terms is hardly possible.

7 Conclusions

We believe that value chain of an organization enables to enjoy the competitive advantages. However, this value chain should be driven by some strong building blocks considering the modern business. The weakness of these building blocks raise cost regarding quality. Bad performance of these drivers also raise opportunity cost in the market which may compels an organization to phase out form the market.

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Appendix: Factor analysis

Table I

N=37, Retained factors=2, number of params=9				
Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor 1	1.95508	0.88250	0.3910	0.3910
Factor 2	1.07258	0.26231	0.2145	0.6055
Factor 3	0.81027	0.14210	0.1621	0.7676
Factor 4	0.66818	0.17428	0.1336	0.9012
Factor 5	0.49389	-	0.0988	1.0000
LR test: Independent vs. Saturated: Chi2(10)=19.96, Prob>chi2 = 0.0296				

Table II

Factor Loadings (pattern matrix) and unique variances			
Variable	**Factor 1**	**Factor 2**	**Uniquenss**
Product design	0.6207	-0.6263	0.2224
Man	0.6150	0.3557	0.4952
Material	0.7180	-0.4407	0.2909
Utility	0.6060	0.5057	0.3770
Technology	0.5557	0.3230	0.5868