COST OF QUALITY AS A SCOREBOARD TO EVALUATE SAWMILLS' SUCCESS IN ACHIEVING QUALITY OBJECTIVES AND BETTER PERFORMANCE

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ABSTRACT

The concept of "cost of quality" emerged in the 1950s but is relatively new or absent in developing countries like Tanzania. Developed countries have benefited from the advantages of using this concept to gain competitive edge above others. Traditionally, the reporting of quality-related costs had been limited to inspection and testing while all other costs like scrap and rework, customer complaints and returns, product recalls and others were accumulated in overhead accounts. Such systems are too aggregated and too distorted to be relevant for managers' planning and quality control decisions. They provide little help for reducing costs and improving both quality and productivity. Experience from the sawmill industry in Tanzania indicates that most sawmills report quality related costs in a traditional way. A change is inevitable if sawmills are to meet quality objectives and improve performances. This study is an effort towards initiating such a system in the sawmill industry in Tanzania. The study observed that there was no cost of quality reporting system at the study mill and costs of quality at the mill were rising. Annually, on average, there was a cost increase of 10, 21 and 10 % on prevention, appraisal and internal failures, respectively. The production department was found to be the main source (78%) of quality costs. The activities in the department that were found to contribute more to quality problems included downgrading of lumber due to poor quality(27%), maintenance of saws (18%), reworking/resawing (12%), process control (10%), and test and inspection (12%). These areas could serve as a starting point for a quality improvement programme.

Keywords: *Sawmill, cost of quality, quality and profits*

INTRODUCTION

The goal of most companies is to conduct business in such manner that an acceptable rate of return is obtained by the shareholders. This goal cannot be achieved if control of quality of products or services is not taken into consideration. In other words, quality is one of the most important criteria for any company to make profit. The issues of quality have existed since tribal chiefs, kings and pharaohs rules. The modern history of quality is marked by great advances between 1920 and the 1950s by George Edwards, Walter Shewhart, W. Edwards Deming, Armand Feigenbaum and Joseph Juran (Gitlow *et al.* 1995). Defining or determining quality levels could be quite subjective depending on one's viewpoint on what quality is. For example, Garvin (1984) provides five definitions of quality. In the first definition, he defines quality as synonymous with superiority or innate excellence i.e. relative quality, in this sense quality is absolute and universally recognizable. Secondly, he provides a product-based definition that cites quality as a precise and measurable variable and that differences in quality

reflect differences in quantity of some product attributes. A third definition is based on the presumption that quality is determined by what a customer wants and he or she is willing to pay for. In other words, quality is meeting or exceeding customer expectations. A fourth definition is manufacturing based. It says that quality is an outcome of engineering and manufacturing practices or conformance to specifications. Finally, the value based definition states that quality is defined in terms of costs and prices i.e. the higher the cost the higher the quality of the product or service. While all these definitions capture what quality is in a broad context and one definition cannot take priority over the other, there is need to have a single variable that could measure success in achieving quality objectives.

The concept of "cost of quality" emerged in the 1950s but it is relatively new or absent in developing countries like Tanzania. The costs of quality are those costs associated with avoiding poor quality or those incurred as a result of poor quality (Evans and Lindsay 1993). This concept was initially popularized by Crosby (1950) and is currently popular in most of the industrial world. The importance of cost of quality concept lies in the fact that quality problems are translated into a language that can easily be understood by top management i.e. monetary terms. Where the concept of controlling quality is working, all organizations measure and report costs of quality as a basis for control of quality and improvement. Developed countries have benefited from the advantages of using this concept to gain a competitive edge in the industry. Traditionally, the reporting of quality-related costs had been limited to inspection and testing while all other costs like scrap and rework, customer complaints and returns, product recalls and others were accumulated in overhead accounts (Evans and Lindsay 1993). But as managers began to define and isolate the full range of quality-related costs, a number of surprising facts emerged. First, quality-related costs were much larger (in the range of 20-40%) than had been traditionally reported; second, quality-related costs were not only related to manufacturing operations but also to ancillary services such as purchasing and customer service departments; third, most of the costs were a result of poor quality and were avoidable. As a result, many companies began programmes in cost of quality. Despite the increasing importance of accounting for quality costs, most accounting systems up to now are poorly designed to handle the task of accounting for such costs because the information derived by those systems are too aggregated and too distorted to be relevant for managers' planning and quality control decisions (Evans and Lindsay 1993). Such systems provide little help for reducing costs and improving productivity and quality, and do not produce accurate product costs for pricing and response to competition.

Experience from the sawmill industry in Tanzania indicates that most sawmills report quality related costs in a traditional way, i.e. costs of quality are not reported separately but are accumulated in overhead accounts (Y. Mkollo 2007 personal communication). A change is inevitable if sawmills are to meet quality objectives and improve performances. There is therefore, need to borrow a leaf of experience from the industrialised world by initiating cost of quality programmes in order to produce quality products.

This study was an effort towards initiating such a system in the sawmill industry in Tanzania. Although the study targeted sawmills, the method could be adopted by other industries or service firms.

The specific objectives of the study were to:

1. Qualification of cost of quality in each category

2. Determine costs of quality in each
3. category and their major sources

METHODOLOGY

Study mill

The study was conducted at Sao Hill Timbers Ltd sawmill located in Mufindi district in Iringa region, Tanzania. This sawmill is hereafter called a study mill. The study mill has an installed capacity of 35000m^3 of sawn wood per year and the actual annual production volume fluctuates between 16,000 and 20,000m^3 (Mwamakimbullah and Hamza 2007). This mill is one the largest sawmills in the country and expectedly has organised accounts and that served to a good reason to study it. The study mill has four Departments which are Production, Technical, Purchasing and Accounting

Qualification of cost of quality in each category

Four primary costs of quality categories i.e. prevention, appraisal, internal and external failures as identified by Stevenson (2005) were the key areas of interest of the study. In each cost category, cost-items were detailed and grouped in right categories. Therefore, a comprehensive cost structure in each category of cost of quality was done.

Prevention costs

These were costs expended in effort to keep nonconforming products from occurring and reaching customers (Russel and Taylor III (2007). Prevention costs are those incurred during planning, implementation and maintaining a quality system. They include costs such as i) quality planning costs i.e. costs associated with the time spent during planning of the quality control system (salaries and developmental costs for product design, process and equipment design, process control techniques, process capacity improvement and other costs associated with making the product right the first time ii) process control costs i.e. costs spent in order to improve capability and the implementation of process control plans iii) information systems costs i.e. salaries/time expended to develop data requirements measurements, and analysis iv) training costs i.e. those costs associated with developing and operating formal training programs or attending seminars/workshops on quality assurance and v) general management costs i.e. costs for clerical staff, supplies and communications related to the quality efforts.

Appraisal costs

According to Gaither and Frazier (2007), these costs included i) test and inspection i.e. those associated with measuring, evaluating, or auditing products, work-in-process, and finished goods or purchased materials to determine their degree of conformance to the specified standards (salaries for inspectors, supervisors, and other personnel) ii) the costs of maintaining instruments, calibration of gauges, test equipment and repair of such instruments and iii) process control costs i.e. the cost of time spent by operators in gathering and analyzing quality measurements.

Internal failure costs

Internal failure costs were considered to be those incurred when products, components, materials and services failed to meet quality requirements prior to be sent to customers (Slack *et.al.* 2007).

These costs included: i) scrap and rework costs (materials, labour, and overhead costs associated with reworking), ii) the cost of

lost production time due to nonconformities, iii) costs to determine the cause(s) of the product failure, iv) the costs for re-inspecting items after rework and v) down-grading cost i.e. lost revenue from selling products at lower price than normal due to poor quality.

External failure costs

External failure costs were considered to be those incurred when products did not perform satisfactorily after the ownership had been transferred to the customer (Gaither and Frazier 2007). External costs included: i) cost arising due to customer complaints e.g. cost of investigation and adjustments; ii) costs associated with receipt, handling, repair or replacement of nonconformities; iii) warranty charges related to failure of a product within warranty time; and iv) product liability costs of legal action and settlements.

Costs of quality and their sources

The costs of quality in each category were then collected by Departments for two main reasons: i) to determine departments' contributions to the sawmill's cost of quality and hence create awareness for them to participate in a cost of quality programme and; ii) to pinpoint areas of high cost of quality and thus make them focal points for quality improvement efforts.

The cost of each cost item in the cost category (TZS) was collected and entered in the proposed cost of quality reporting system (Table 1).

Data analysis

Cost of quality indices

Quality costs themselves provide little information since they may vary due to production or seasonality. Index numbers are often used to analyse them (Gaither and Frazier 2007). Therefore, measurement variables that are sensitive to change such as labour, manufacturing costs, sales, and units of products are often used (Slack, *et. al.* 2007). However, in this study, units of products index was used. The index was calculated using the following expression (Evans and Lindsay 1993) :

$$Unit\ Base\ Index = \frac{Total\ quality\ costs}{Total\ number\ of\ units\ produced}$$

Trend of cost of quality at the study mill

Costs of quality at the study mill for three consecutive years were collected to establish the trend. Excel spreadsheet was used to plot the trend.

Pareto analysis

Generally, the pareto analysis filters the vital few causes of most of the problems (Chase and Acquilano 1992, Kume 1992). In the study, the analysis was used to filter the vital few causes of most of quality problems in lumber manufacturing. These vital few causes could be the main focus of quality improvement programme (Howard *et al.* 1995). Unit-based indices of cost items were used as inputs to the analysis.

Table 1: Cost of quality reporting system in the sawmill industry in Tanzania

Cost of quality	DEPARTMENTS							
	Purchasing	TZS	**Production**	TZS	**Technical**	TZS	**Accounting**	TZS
	Activities		Activities		Activities		Activities	
1.0 Prevention costs								
I.1 Quality planning	Meetings and seminars		Setting & resetting of machines		Setting & resetting machines		Meetings and seminars	
			Brochures and placards		Brochures and placards		Logistical arrangements	
1.2. Process control	Tools and equipment		1. Lumber treatment		Setting & resetting machines		2. Logistical arrangements	
			2. Lumber drying					
			3. Lumber production					
1.3. Information system costs			Development of a template: data to collect, how to measure and analyse		Logistical Support		Logistical Support	
1.4. Training costs	Training of log quality graders		Short term training of sawmill operators and timber graders		Training of saw doctors		Logistical Support	
			Training of kiln operators				Logistical Support	
			Training of treatment plant operators				Logistical Support	
			Any other long term training				Logistical Support	
1.5. General management	Clerical staff training		Clerical staff training		Clerical staff training		Logistical Support	
	Communication costs		Communication costs		Communi-cation costs			
TOTAL								
2.0 Appraisal costs								
2.1 Test and inspection costs	Log grading in the forest and at the log yard		Log & lumber quality grading				Logistical Support	
2.2 Costs of instrument and saws' maintenance			Process control and supervision		Daily maintenance of saws			
					Weekly maintenance of machines			
TOTAL								
3.0 Internal costs								
3. 1. Reject costs			Value of lumber which is unfit for use					
3. 2. Rework costs			Re-sawing costs					
3.3. Down- grading costs			Costs of degrading lumber due to poor quality					
TOTAL								
4.0 External failures								
4. 1. Costs of investigation of complaints raised by customers								
4. 2. Costs of handling and replacement of non-conformities								

4.3. Liability costs as a result of poor performance of company products
TOTAL

RESULTS AND DISCUSSION

Figure 1 shows contribution by categories of cost of quality to total cost of quality. It can be observed that costs due to internal failures, i.e. those costs incurred when products failed to meet quality requirements prior to transfer of ownership to the customer where the highest (42%). These costs could be turned into profits if there were no nonconformities, in the production process and lumber was properly handled in subsequent operations before being sold.

Cost of quality by category

Prevention costs came second followed by appraisal costs. Although costs due to external failures were rated at 0%, that does not mean that there were no complaints from the customers of the mill. Customers of lumber in the country are generally insensitive to lumber quality which evidenced by the fact that almost all lumber produced at the study mill is sold. Apart from that, the mill does not keep records on customer complaints or their respective costs. This is a shortfall.

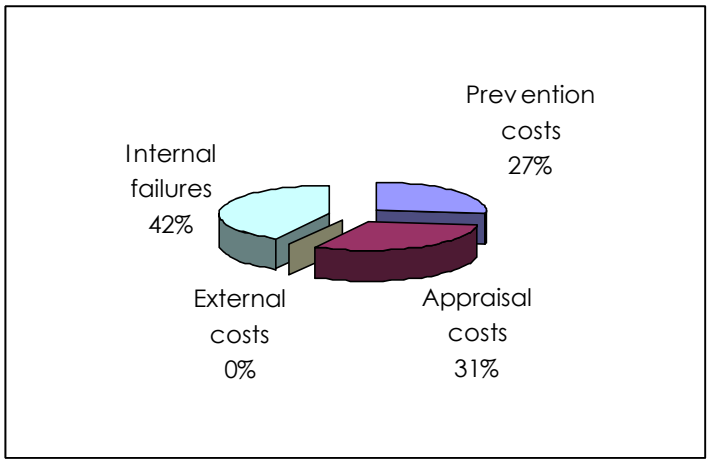

Figure 1: Contribution of each category to the total cost of quality

The sources of costs of quality by cost items

Table 2 presents unit-base indices for cost items identified. It is noted that on top of the list are costs associated with downgrading of lumber due to poor quality, followed by maintenance of saws, reworking, process control, and test and inspection. Together, these three cost items make up about 80 % of the observed total cost of quality per m^3. Of these costs, downgrading of lumber, maintenance of instruments and saws, rework and process control belong to the internal failure cost category. Being higher on list, indicates that internal failure costs were the highest among the four categories. Such results are expected in a situation whereby a quality control programme is not practiced/ existing. These findings from this study are supported by Evans and Lindsay (1993), who estimated that 60 to 90% of total quality costs are a result of internal and external failures.

Table 2: Unit-base indices costs of quality by cost items

Cost items	Unit-Index values (TZS/m^3)	%
Down grading costs	885.33	27.99
Maintenance of instruments and saws	559.18	17.68
Rework/resawing costs	379.43	12.00
Test and inspection costs	379.43	12.00
Process control	323.83	10.24
Quality planning	271.48	8.58
Information system costs	155.42	4.91
Training costs	91.20	2.88
Reject costs	80.21	2.54
General management	37.51	1.19
Total	3163.03	100

Pareto analysis output

To give a graphical view, unit-index values in Table 2 were used in Pareto analysis. The result is presented as Figure 2. From the figure, the vital and trivial causes are clearly seen. The vital few could include the first five bars on the left of the figure. A quality improvement programme initially could focus on these. Once such a programme is put in place and working properly, it is more likely that costs such as lumber down grading, reworking and reject could be recuperated.

However, quality improvement should be a continuous process, once the vital few causes of cost of quality are addressed, those which had little weights become vital and accordingly measures to address them need to be strategised.

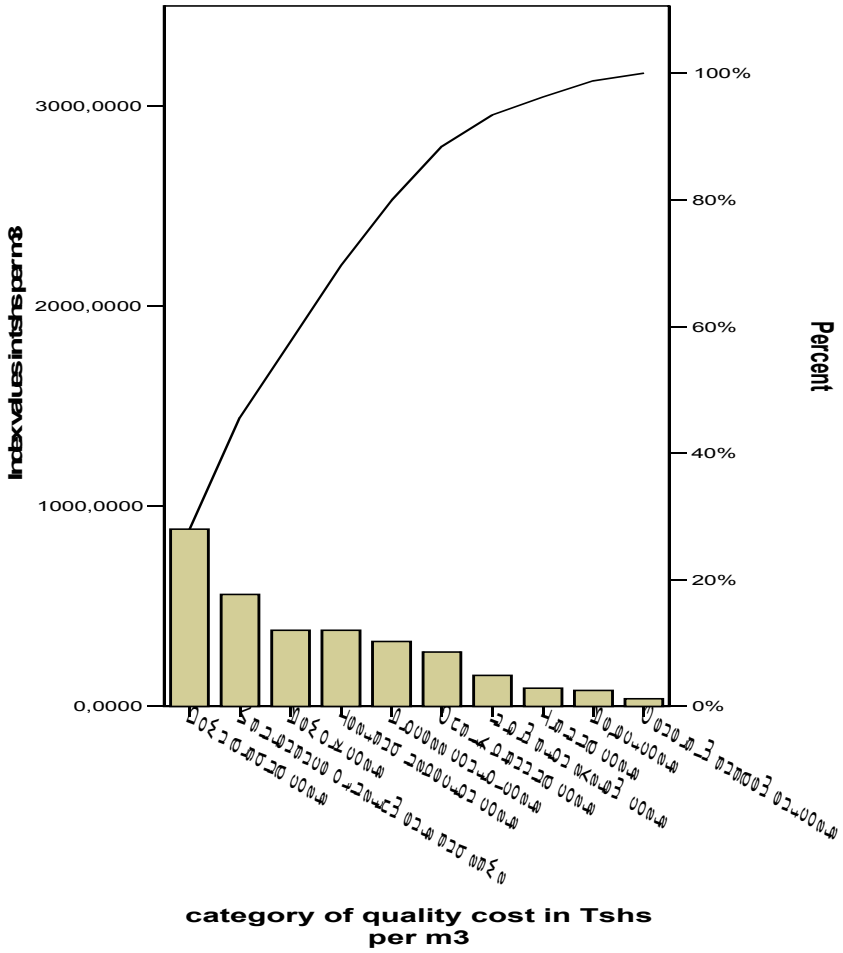

Figure 2: Contribution of categories of cost of quality to total cost of quality

Generation of cost of quality at the study mill by Departments

Activities which generate costs of quality and their Department of origin are presented in Table 3 and graphically in Figure 3.

Both Table 3 and Figure 3 confirm that a lot needs to be done in the production Department if the mill is to make savings from improved products' quality. Almost 80% of costs of quality originate from activities performed in this Department.

Table 3: Cost of quality by departments

s/n	Activity	Department
1	Lowering cost / Down grading of lumber	Production
2	Maintenance of saws	Production +Technical
3	Supervision for quality and Log & lumber quality checking	Purchasing +Account+ Production
4	Reworking	Production
5	Setting, resetting & Control machines for quality improvement	Production +Technical
6	Lumber treatment	Production
7	Data keeping & development	Production + Account
8	Meetings& seminars for quality planning	Purchasing +Account
9	Training of log checkers, operators and saw doctors	Production +Purchasing +Technical
10	Rejected lumber	Production
11	Communication between log &lumber checkers	Production +Purchasing +Account

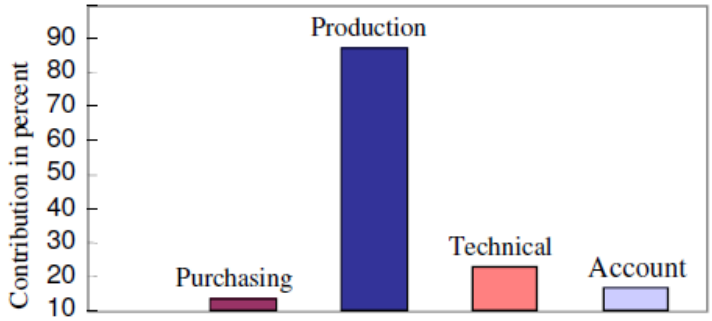

Figure 3. Contribution to cost of quality by Departments

These activities and those identified through Pareto analysis, must be the focus of a quality improvement programme.

Trend of costs of quality at the study mill

The trend of cost of quality for a period of three consecutive years is presented in Figure 4. Except for external failures which were not recorded in this study, all other costs are on the rise. On average, there was a cost increase of 10, 21, and 10% per annum on prevention, appraisal and internal failure costs, respectively. The increase of these costs provides evidence of lack of recognized and approved system of quality control, and low quality awareness among workers.

A similar study conducted and presented by the British Standard (1991) shows that presence and application of quality control programmes leads to decreasing overall costs of quality and consequently in a good savings (Figure 5). In Figure 5, the costs of quality decreases as the quality awareness and quality improvement activities increase. The trend observed at the study mill indicates that both quality awareness and quality improvement activities are low and as a result as years pass by costs are increasing

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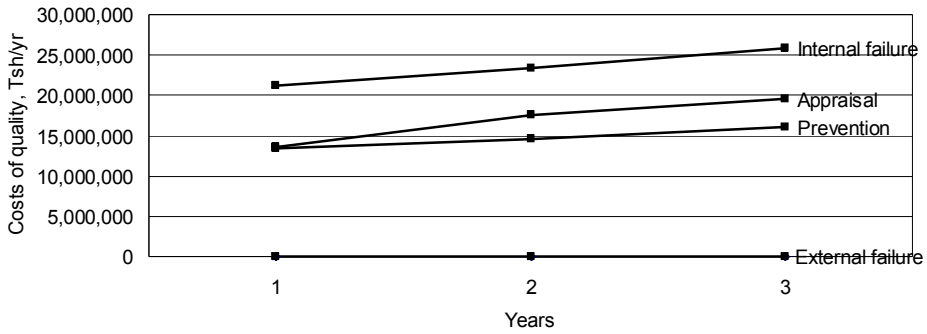

Figure 4. Trend for costs of quality at the study mill

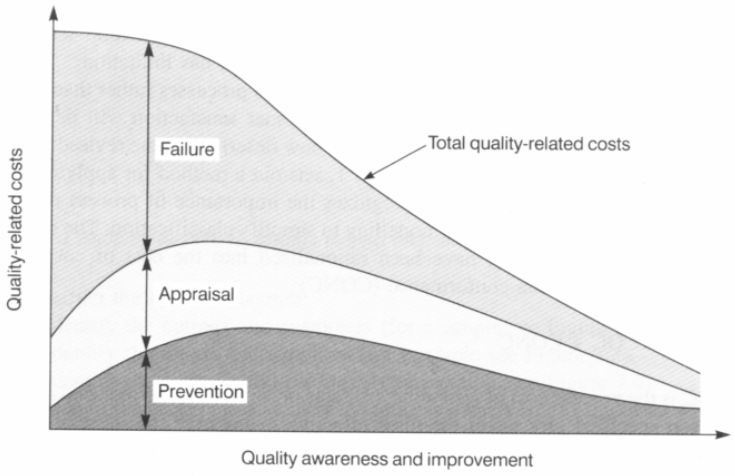

Figure 5. Effect of increasing quality awareness and improvement activities on quality related costs. Source: British Standard (1991)

CONCLUSION AND RECOMMENDATIONS

Conclusion

There was no cost of quality reporting system at the study mill and these costs were on the rise. On average, there was a cost increase of 10, 21, and 10% per annum on prevention, appraisal and internal failure costs, respectively.

The production department was found to be the main source (80%) of cost of quality.

It is noted that activities that contributed more to costs of quality in the Department included lumber down grading, followed by maintenance of saws, reworking, process control, and test and inspection.

The mill could have forgone a lot of benefit (costs savings) as a result of failure to introduce a quality improvement programme.

Recommendations

It is high time Sao Hill Timber LTD and other sawmills think of adopting a cost of quality reporting system such as the one used in this study. Using such a system, quality-related problems could be translated into monetary terms. In such terms, one can easily know how much is being lost due to production of poor quality products and thus take immediate steps to remedy the situation.

Reworking or resawing and degrading were cited as major contributors to costs of quality. The mill could to take measures to reduce them through making it right the first time and training of operators.

The key to improving quality and profitability is prevention of defectives to occur. It has been proven that an increase in prevention expenditures will generate larger savings in all other quality cost categories.

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