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Abstract: A new, unmistakable vista of quality is taking place in the world. Consumers are increasingly basing their purchasing decisions on the quality of goods and services. They are even willing to pay more for the confidence and assurance of quality. This message is being received by producers, with mixed emotions. Quality apparently is still being treated casually by some manufacturers. Where quality has been at the fore front of management strategies, the sharper quality focus is an invited challenge. Dramatic progress is being made by companies which had the foresight to absorb the quality and productivity message and now continue to assertively transform quality commitment into action. These companies place sufficient emphasis on quality that with each shipment, or negotiation, consumer confidence is strengthened. There is good reason for this business strategy, decades of effort toward building a good company reputation can be negated by a single shipment of defective product.

The Cost of Quality

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RESEARCH PAPER
THE COST OF QUALITY

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INTRODUCTION

A new, unmistakable vista of quality is taking place in the world. Consumers are increasingly basing their purchasing decisions on the quality of goods and services. They are even willing to pay more for the confidence and assurance of quality.

This message is being received by producers, with mixed emotions. Quality apparently is still being treated casually by some manufacturers. Where quality has been at the forefront of management strategies, the sharper quality focus is an invited challenge.

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1. THE DEFINITION OF QUALITY

1.1 WHAT IS QUALITY

The concept of Quality Control has been discussed since the early 1950's when it first became a problem, but it has only recently become a topic of interest to management consultants. In the middle of the 50's, a shift from *Quality is our most important product* to *Quantity is our most important product* appeared. The replacement of defective products then became common.

The definition of Quality is not, unfortunately, a single and specific definition adopted by all the experts. One definition is Crosby's [3], stated as *Quality is the degree of conformance*, but not just to the product requirement specification. Conformance has to be directed to the customer's need (and that need must be limited by price and delivery considerations). This definition of Quality finds many supporters such as, Juran [5], who introduces the term *fitness for use*, Hayes [4] and Morse [2] who writes :

This concept of fitness for use popularly called by such names as "Quality" is a universal concept applicable to all goods and services. "Fitness for use," is determined by those features of the product which the user can recognize as beneficial to him, e.g., fresh baked taste of bread, clear reception of radio programs...

Hayes adds [4] (p 25)

The spirit of Quality, however means this and more. Quality needs to be regarded as a dynamic goal, carrying the connotation of challenge and continuous improvement.

Moreover, for Crosby [10], *The only performance standard is zero defects.* Many people have difficulty with this. The position of Grocock's book [7] is that as a general statement of final purpose and as an expression of a refusal to compromise in establishing quality standards, *it is excellent..* (p289) But he finds something more realistic: measuring the ppm (parts per million) of defects.

A careful semantic analysis reveals some problems, but such an analysis is not relevant to Crosby's purpose.(...) The difference between defects and failures was examined; it was shown that achievement of zero functional failures was not only practicable but necessary, and that achievement of ppm failure proportions was now a practical requirement for some products.

CONCLUSION

The concept of Quality is not an easy concept as it interferes with subjective feelings such as aesthetics and perception.

Moreover, the degree of Quality, as measured in ppm failure proportion, depends on the company vision for Top Quality Products. The proportion varies accordingly to the company policy.

The European Organization for Quality Costs (E.O.Q.C.) and American Society of Quality Costs (A.S.Q.C.) use the same broad definition for Quality: *The totality of features and characteristics of a product or service that bear on its ability to satisfy a given need.*

1.2. HOW TO BUILD A TOP QUALITY PRODUCT

Describing Quality is one thing, but a company must know how to build a T.Q.P.. We can find four major approaches to T.Q.P.. They are listed below.

1.2.1. Hayes approach: The Team Effort

Hayes [4] (p38) finds eight key links to Quality which are in turn "linked" to the Quality assurance organization. These links are illustrated in the figure II-2.

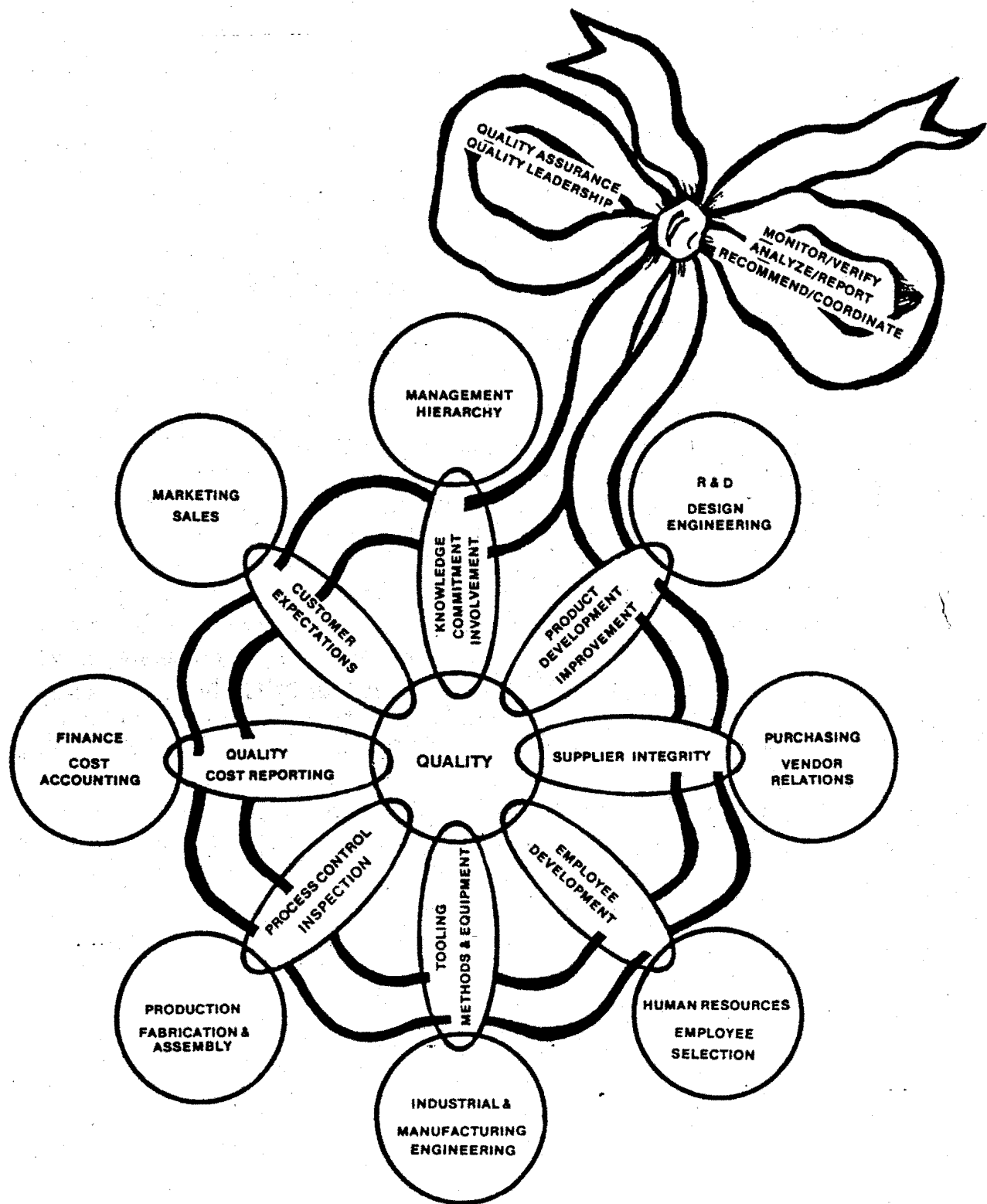


FIGURE II-2. THE EIGHT KEY DIRECT LINKS TO QUALITY

- level 1: Quality functions are regarded as road blocks to making quick deliveries and are viewed as obstructions to progress.

- level 2: Confusion about what to do to improve quality. Customers complain about quality and sales. Companies experience production and quality crisis. Quality has enough identity to result in dual standards, erroneous assumptions, and other causes of confusion. The company needs more knowledge and commitment to quality by the top officials.

- level 3: Quality is given more credibility and recognition. Preventive measures, if reported is about 5% of top quality cost, and inspection and failure costs are about 95%. Companies are turning the corner to a better product posture. Unproductive habits are being unlearned and new stimuli introduced. A change of attitude about among the top management including Production and Quality departments is seen.

- level 4: Companies are becoming quality leaders in their industries. Quality is fully recognized as a predominant factor in not only maintaining the competitive edge, but a leading criterion for productivity improvement. Every eight key levels are concerned about quality.

- level 5: This level represents a goal for most companies. Employees are given flexibility in work assignments and attendant training. Organizational marketing for participation by employees are established at all levels in the organization, but objectives are set and performances are reviewed. The management at all levels practice a consistent, fair and democratic style of leadership. Top executives are truly committed to quality and actively support activities that indicate this commitment.

1.2.2. Crosby approach: The 14 steps Quality Improvement

Crosby [10] proposes a step by step approach to access to T.Q.P.

1. *Management commitment*
2. *Quality improvement team*
3. *Quality measurement*
4. *Cost of quality evaluation*
5. *Quality awareness*
6. *Corrective action*
7. *Establishment of an ad hoc committee for the zero defects program*
8. *Supervisor training*

9. *Zero defects day*
10. *Goal setting*
11. *Error cause removal*
12. *Recognition*
13. *Quality councils*
14. *Do it over again*

The first step, management commitment, is fundamental to any effective philosophy of quality improvement. Quality improvement never happens automatically but must be planned and managed.

Step 2: The quality improvement team provides this framework. It is needed to establish priorities for action, record commitments, assign resources, and monitor progress. Its responsibilities embrace the unit's whole quality improvement program and it needs to be chaired by someone in authority (for example a plant manager).

Step 3: Quality measurement. The improvement depends of the analysis of quantitative data. It is the basis for both statistical process capability and control and it represents a means by which good suppliers are identified to bad, and it enable the progress of good suppliers to be monitored as they improve.

Step 4: Cost of quality which is detailed in part 2: Economic costs of T.Q.P.

Step 5: Quality awareness. One aspect is a continuous advertising program, that uses posters, articles in the unit's newspaper, and so on to raise awareness about quality improvement. I have worked for a B.S.N. factory which was posterizing every complaint for customers in the concerned department, and curves showing the evolution of the complaint in quantity and contents. In doing this, the employees gain confidence and commitment in management's genuine dedication to quality improvement.

Step 6: Corrective actions to avoid meeting the same defects. Employees bring their problems to the supervisor who try to generate solutions. In the empowered teams, the employees try to solve their problems within their team.

The next three steps, and step 13 refer to the establishment of the formal organization necessary to the implementation of the Quality Improvement Plan. The zero defect day is a ceremony to boost the Quality Improvement Program.

Step 10: Goal setting. The goals must be measurable and the targets must have specific achievement date.

Morse [2] advises this methodology:

- Generate a list of elements resulting in the cost of finding errors, the cost of correcting errors and the cost of preventing errors.
- Identify those elements which contribute to 85 to 90% of the total cost of quality.
- Categorize the 85 to 90% into the basic categories of prevention, appraisal, internal and external failure costs as detailed below:

I. Prevention costs. These are the functions and activities, including wages and salaries of people whose efforts focus on anticipating and planning to achieve established quality objectives and avoiding unwanted costs.

A. Training provides the employees with the competence needed to achieve quality objectives.

B. Process control techniques allow statistical predictions to be made about future events so that intelligent choices can be made. (This also includes equipment capability studies.)

C. Special equipment is purchased to provide the desired and consistent quality.

D. Design reviews are conducted to assure the integrity of design packages before they are released for production.

E. Vendor assurance is achieved through pre-award surveys to verify in advance that a prospective supplier is qualified to produce the required quality.

II. Appraisal costs. These include the wages of people who are involved in inspection and test functions and activities. They do not include reinspection and retest after rework. Here are the principal categories:

A. Clerical and supervisory jobs of inspectors.

B. Laboratory and test analysis of purchased items.

C. In-process and final inspection labor hours.

D. Gage calibration and repair of instruments used for inspection.

E. Quality audits as a second order verification of systems operations and inspection integrity.

F. Source inspection conducted at the vendor.

G. Receiving inspection of purchased parts.

F. Field inspection is conducted at the customer's site after delivery.

III. Failure costs. These include internal and external failure costs.

III-I. Internal Failure costs. These are all losses (including shop overhead) due to problems in in-house engineering, manufacturing, quality or similar errors during production.

A. Scrap costs include all material and lost machine and labor time due to chance failure, operator error, purchased parts failure, lost parts, mishandling and process error. These should not include obsolete units or overruns.

B. Rework costs include labor used to rework items (bring an item up to the acceptable quality standard) due to in-house engineering, manufacturing, quality or similar errors.

C. Failure analysis of units which fail before delivery.

D. Vendor analysis charged by vendor.

E. Sort or retest of reworked items including additional machine time.

F. Failure investigation.

G. Evaluation of corrective action.

H. Material Review Board activities.

I. Down time due to:

1) quality problems

- 2) insufficient preventive maintenance
- 3) lack of equipment capability

III-II. External failure costs. These are quality costs that develop after shipment of an order.

- A. Customer complaints, investigation and service.
- B. Allowances which usually include customer abuse or misuse.
- C. Machine replacement or repair and installation, if applicable.
- D. Field costs including material associated with handling costs.
- E. Negotiation and analysis costs.
- F. Associated vendor costs.
- G. Product liability costs.
 - 1) legal actions
 - 2) insurance and warranties
 - 3) safety claims
 - 4) consequential damage
- H. Usage and carrying costs of spares.

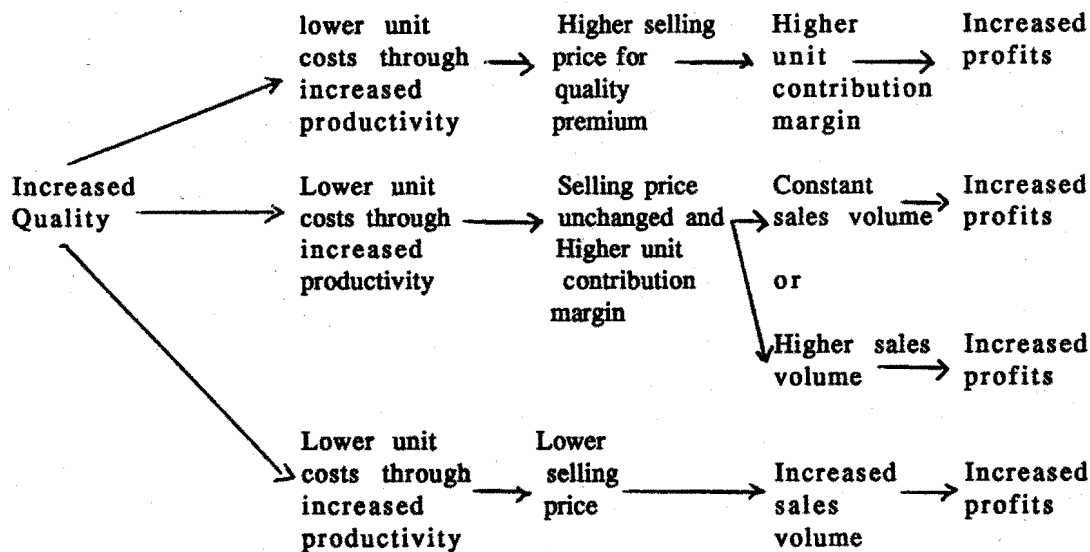
All of these costs must be converted in dollars for the economic analysis. Some costs may not occur in a company improvement plan.

Usually, prevention is less costly than reparation cost. Moreover, internal costs should receive more emphasis in order to avoid external costs. Crosby [3] has showed that scrap, rework, warranties, inspection and testing cost commonly exceed 15% of the sales. A greater emphasis on defect prevention could decrease this cost to 3%.

2.2 Benefits

The major benefit of improving quality is the improvement of productivity. One common misconception concerning quality and productivity is that productivity and quality are incompatible: "You can have one or the other, but not both." Another misconception is that higher quality can be attained only at greater cost: "If you want

Quality, Productivity, and Profitability



2.2.2. Quantifying the impact of quality

Kaydos has made [8] (p27) some studies to quantify the impact of quality. These studies have estimated that as much as 30 percent of a company's resources can be spent correcting quality problems that shouldn't happen in the first place. Based on his experience, those figures are quite reasonable. In one case, a detailed analysis showed the cost of remaking a product was \$5.76 versus a cost of \$0.72 for doing it right the first time. Roughly 35 percent of indirect and direct costs were being spent on correcting or compensating for quality problems. These problems occurred at many points in the production process and affected about 6 percent of the products. In other words, 35 percent of manufacturing labor costs were being spent on only 6 percent of the plant's production.

Failure to recognize the large impact of apparently small quality problems leads managers to reach the wrong conclusion that big opportunities for increasing performance don't exist. When a small portion of poor quality work is consuming a large share of resources, improving quality increases productivity much more than is readily apparent.

3. OTHER COSTS

Some other costs due to poor quality products, opportunity costs, do not appear on an income statement, but it always pays to reduce them. Improving quality can improve safety, reliability, and customer service.

3.1. Safety

Perhaps the most common reason for a product falling short of the needs of the customer is its inadequate reliability or safety. There are two explanations for this. First, it is more difficult for a customer to determine the safety or reliability of a product than it is to assess its functional performance, appearance, and other immediate characteristics. If such characteristics are unappealing the product will not sell. The manufacturer, therefore, is forced to satisfy these particular aspects of the customer's need. However, the manufacturer may well be able to sell products with unsatisfactory safety or reliability because the customer cannot recognize this at the same time of sale. Also, because reliability and safety are probabilistic, the majority of customers may have no problem with the product. This is no comfort though to the unlucky minority that do. The second reason for inadequate product reliability and safety is that making safe and reliable products, and measuring how safe and reliable they are, is difficult because functional testing does not usually work effectively for these characteristics. A company that is serious about quality improvement, therefore, has to give special attention to reliability and safety.

This regard to safety is largely develop by Haynes [4] (p286).

3.2. Customer service

When a client buys a product from a company and must send it back because of a defect, even if he receives a new product in a short time, he will have a bad opinion of the company. I can give the example of a model of Moulinex toaster. The whole sery was deficient. They had to build a new model, more sophisticated than the previous one, to send to the clients. Even with this action, their toaster sales decreased by 20%. They lost people's confidence and therefore, they lost sales.

3.3. Public Image

In the opposite, when a customer finds a society whose products always fit their expectations, even if he has to pay more for this product, he won't hesitate and will choose this company product. Therefore, the public image of the company will be enhanced thanks to the top quality of their products. Kaydos [8] states (p29-30)

The highest cost of all is a damaged reputation and the customer that never comes back. Ask GM, Ford, and Chrysler.

3.4. Conclusion

Even if safety and reliability, customer service and public image considerations cannot be included in the economic analysis, managers should not forget them in their struggle to improve the quality of their products.

4. ECONOMICS ANALYSIS

We can find, in the literature, two types of quality cost analysis: the TRW approach and the Lundvall approach.

4.1. The TRW approach

This approach consists in evaluating the quality costs savings in budgeted year.

$$\text{Qual. Cost Sav.} = \left[\frac{\text{QC}}{\text{sales}} \right]_{\text{base year}} - \left[\frac{\text{QC}}{\text{sales}} \right]_{\text{budgeted year}} \times \text{sales}_{\text{budgeted year}}$$

This method had been successfully used by several companies such as STC, ITT Europe or Organization of Petroleum Exporting Countries, until 1973. They realized that when their sales begin to decrease, the "fixed" part of the quality cost was deteriorating the quality cost to sales ratio, partially, or even totally, offsetting the effect of real improvements. Therefore, in early 1974, a new method of quality cost budgeting appears, examining the changes in quality cost from one year to the next. These changes are in two categories. The most important changes are reductions in quality costs due to quality cost improvement projects (mainly specific projects, but also general improvements). The second category covers changes due to other reasons: measurement changes, increase or decrease in the volume,

increases in compensation, all other changes resulting from deliberate changes to improve quality-to-the-customer, and quality cost increase due to quality deteriorations.

When keeping track of quality cost improvement projects it is very useful for each project to be defined on a standardized form. There are many different ways which have been developed. We won't detail them.

4.2. The Lundvall approach

Lundvall [1] introduces a "theoretical illustration of the economics of quality" which shows the relation between quality of conformance and quality costs (cf exhibit).

The concept of the three zones associated with the optimum is attributed to Juran and others [5]. The quantification of quality cost ratios for each zone is attributed to Leonard A. Seder. Quality costs are high when quality is low. Total quality cost decrease as quality is improved up to a point where almost perfect quality is attained. At this point, and only this point, quality costs rise with improvement.

The basic curve (1) can be divided in three zones and interpreting as following:

- zone 1: zone of improvement or appraisal
 - failure cost >70%
 - prevention cost <10%
- zone 2: zone of indifference or change
 - failure cost is about 70%
 - prevention cost is about 10%
- zone 3: zone of perfectionism or prevention
 - failure cost <40%
 - appraisal cost >50%

This theory is available for a given level of technology and knowledge. Major breakthroughs in either technology or knowledge should have the effect to shifting the prevention and appraisal cost curves downward and to the right, thereby, increasing the optimal quality level (cf other curves). Thus, this theory illustrates that the search for quality never ends.

4.3. Example of income statement and quality cost

This example is commonly used in estimation of quality cost.

sales revenue	% of sales	quality costs	% of sales
COSTS direct manufacturer indirect manufacturer administrative warranty & service	100%	-	100%
total costs			
operating profit	-	-	
quality costs as a % of profit			

Hayes [4] has showed by some studies that usually:

- unit's Quality Cost represent 15% of the sales
- Quality Cost represent 10% of the sales
- supplier Quality Cost represent 5.4% of unit's sale.

4.4. Conclusion

In this brief discussion, the most common methods of budgeting quality costs have been discussed. Most of the companies that measure and report quality costs do not budget their quality costs. They thereby miss a vital part of the whole quality cost system. It may not be overstating the position to say that a quality cost system that lacks formal budgeting and a consequential strong emphasis on planned quality cost improvement projects may be of little value.

5. CONCLUSION

Process quality costs may be in several forms such as material waste, rework costs, management time, and rejects. Product quality

costs may show up as customer complaints, returns, and higher selling costs. *Whether it is process or product quality, poor quality always costs something*, as shown by the figure below.

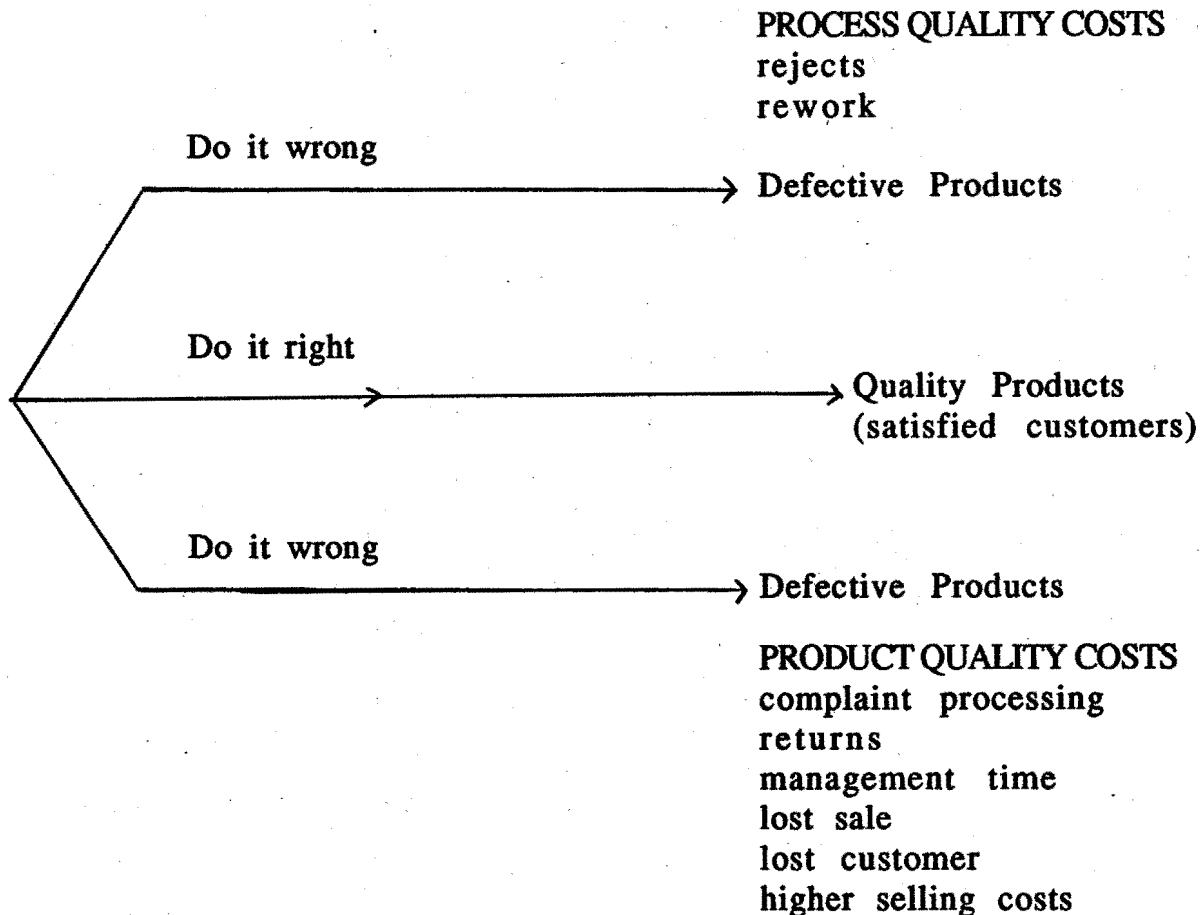


figure: Poor Quality Always Costs Something!

So, we can say that any manager debating whether or not to improve quality is wasting his or her time. It is never a question of economics, assuming quality is increased by improving the production process. In the long run it is always better to improve quality and reap the rewards of higher productivity, lower costs, and satisfied customers. Saying that you can't afford to improve quality is the same as saying you can't afford to do it right the first time, but you can always afford to do it over. Unfortunately, in the increasing competitive world market, your customer may never give you a second chance.

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