Novolyze

The 2023 Outlook on Cost of Quality

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Introduction

Technological advancements in the food and beverage industry are accelerated, and market conditions are highly competitive, strictly regulated, fast-moving, and complex. Such a dynamic operating environment offers companies many opportunities and hidden risks. Consumers' primary needs and demands in such an environment are low-priced, better-quality products. Food and beverage manufacturers prioritize food safety, as they should; however, many underestimate the importance of quality outside organoleptic attributes due to its complexities and economics. In today's competitive business environment, quality has become a prerequisite, not a differentiator. In addition to influencing brand reputation, quality can dramatically impact a company's present and future success. A company's ability to manage quality effectively is crucial in increasing efficiency, reducing unfruitful expenditures, and enhancing profitability in all aspects of its operations. The cost of quality can significantly impact a company's return on investment. Although most companies know what their cost of quality is, they rarely spend the time to analyze the total costs and how they can strategically reduce their quality cost drivers.

The top 6 factors to consider for Cost of Quality in 2023

1. ACCELERATED DIGITAL TRANSFORMATION

We expect to see continued innovation and development within transformative technologies such as artificial intelligence (AI), the internet of things (IoT), virtual and augmented reality (VR/AR), cloud computing, blockchain, and super-fast network protocols like 5G. As a result of new solutions that can improve business decision-making and automate routine manual tasks, intelligent enterprises can be created in which systems and processes complement one another to accomplish menial and mundane tasks as efficiently as possible.

2. INFLATION AND SUPPLY CHAIN DISRUPTIONS

According to economic forecasts for 2023, inflation will continue to rise while economic growth will be modest. Food and beverage companies are still experiencing supply chain problems due to global shutdowns caused by Covid-19 and the ongoing war in Ukraine.

3. SUSTAINABILITY

The food and beverage industry will have to continue ensuring that its environmental, social, and governance (ESG) processes are at the center of its strategic planning. Emphasize improving food and beverage companies' transparency, reporting, and accountability practices. Identifying ways to address sustainability can begin with measuring the impact of their business operations on society and the environment.

4. IMMERSIVE CUSTOMER EXPERIENCE

Customers will place a high value on the quality of their experience with the food products they consume. Food and beverage manufacturers should strive to improve their products' quality and exceed consumers' expectations by acting as the customers' voice.

5. FDA FOOD TRACEABILITY REGULATION

- Proposed Rule (FSMA 204) goes into effect on January 2023
- Establishes additional traceability recordkeeping requirements for people who manufacture, process, pack, or hold foods on the Food Traceability List

6. TALENT CHALLENGES

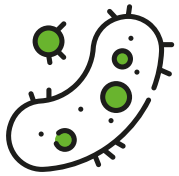
In 2023, the food and beverage industry should invest more in providing fulfilling work, ongoing education and growth opportunities, flexibility, and a diverse and value-oriented workplace for its employees. Intelligent machines and smart robots will increasingly support the future workforce, and this will have far-reaching implications for the skills and talents companies need to compete.

What Drives Quality Cost?

PUBLIC HEALTH AND REGULATORY CONSIDERATIONS

According to the Centers for Disease Control and Prevention, food-borne illnesses affect an estimated 48 million people annually in the United States because food hazards are not identified and controlled during the production, processing, or handling of food products. This number translates to the hospitalization of approximately 128,000 individuals and the tragic death of 3,000 people each year. Adopting food quality and safety systems is no longer a matter of choice but a legal requirement in many countries. There are numerous food safety and quality standards to adhere to in the food and beverage industry, ranging from the FDA's Food Safety Modernization Act (FSMA) and Good Manufacturing Practices (GMP) to Hazard Analysis Critical Control Point (HACCP). It is vital to ensure the safety of the final product through prevention and appraisal processes. In the U.S., food safety assurance regulation is primarily the responsibility of the Food and Drug Administration (FDA) and the U.S. Dept. of Agriculture (USDA) Food Safety and Inspection Service (FSIS). Several other agencies play contributory roles in protecting the quality and safety of food, such as the Center for Disease Control (CDC) and the Environmental Protection Agency (EPA). The United States federal government and its agencies enacted several laws to reduce the frequency and severity of food-borne disease outbreaks. The legislation by these regulatory agencies helped establish inspection requirements for food products, set quality standards for food processors, and ensured food product safety.

Annual impact of foodborne illnesses in the US:



48 million people ill

128,000 hospitalizations

3,000 deaths

IDENTIFYING QUALITY COST THROUGH HACCP AND FMEA IMPLEMENTATION

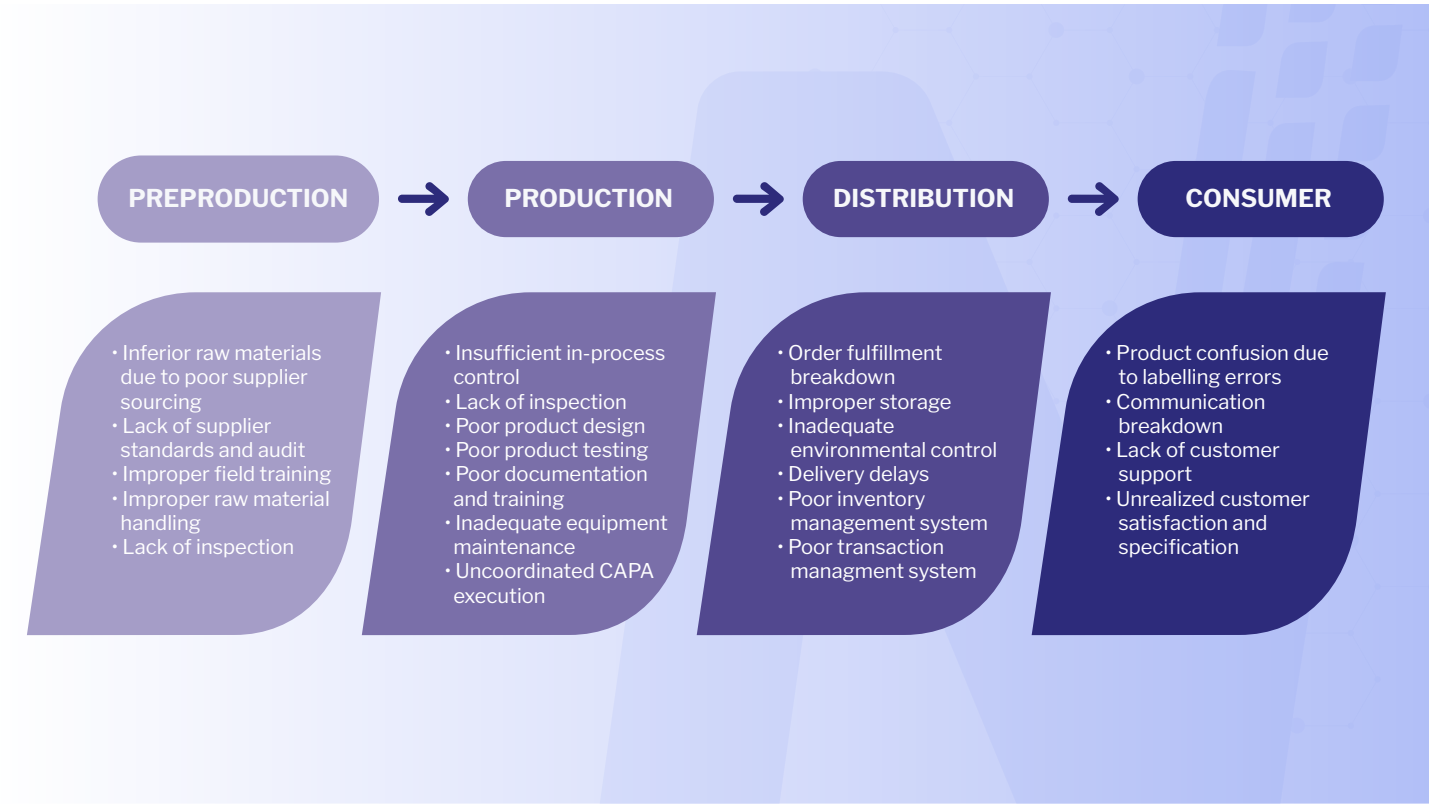
Assessing quality in the food and beverage industry requires utilizing two parameters. First, Failure Mode and Effect Analysis (FMEA) is widely used in numerous industries to improve and manage quality. Secondly, hazard analyses and critical control points (HACCP) are commonly employed to ensure the safety of food products by proactively reducing or eliminating potential safety risks. Food manufacturers can benefit from integrating these powerful tools to improve quality performance and conformance. The goal of HACCP is to reduce hazards throughout the production process. Specifically, a HACCP system establishes process control by identifying, monitoring, and controlling critical control points (CCPs) in the production process. CCPs are points at which the application of control facilitates the removal or reduction of the hazard level.

In general, the identification of CCPs can occur at any stage of production, such as during receiving, processing, packaging, and storage. HACCP plans reduce issues associated with food safety; their preventive approach may be more cost-effective than testing products and then destroying or reworking those that fail. The strategic adoption of a preventative approach is significant for food-borne microbial pathogens since their incidence is low, and testing and reworking are costly procedures. Several factors, including the type of facility, size, and location, affect the cost of HACCP design and implementation, making it essential for F & B companies to assess the cost-effectiveness of HACCP plans before incorporating them.

COST OF QUALITY DRIVERS ALONG THE VALUE CHAIN

We all know the symptoms of poor quality, such as rework, repair, re-testing, customer complaints, raw material rejection, in-process rejection, penalties, and investigations, to name a few. But what drives the cost of quality? The answer to this question requires an in-depth analysis of the entire value chain and an understanding of where process breakdowns lead to quality costs that result in external and internal failures.

Below are examples of process failures that drive poor quality within the value chain:



The Food and Beverage industry can use quality costs to establish a quality system as a starting point unless one already exists. A quality costing system may provide managerial leaders with an overall index to assess the organization's economics, effectiveness, and efficiency of quality activities. In addition, quality costing may highlight areas for improvement by product, service, operation, process, and department. Quality costs integrate all the different quality activities into a total quality system. Consequently, the entire organization must evaluate the

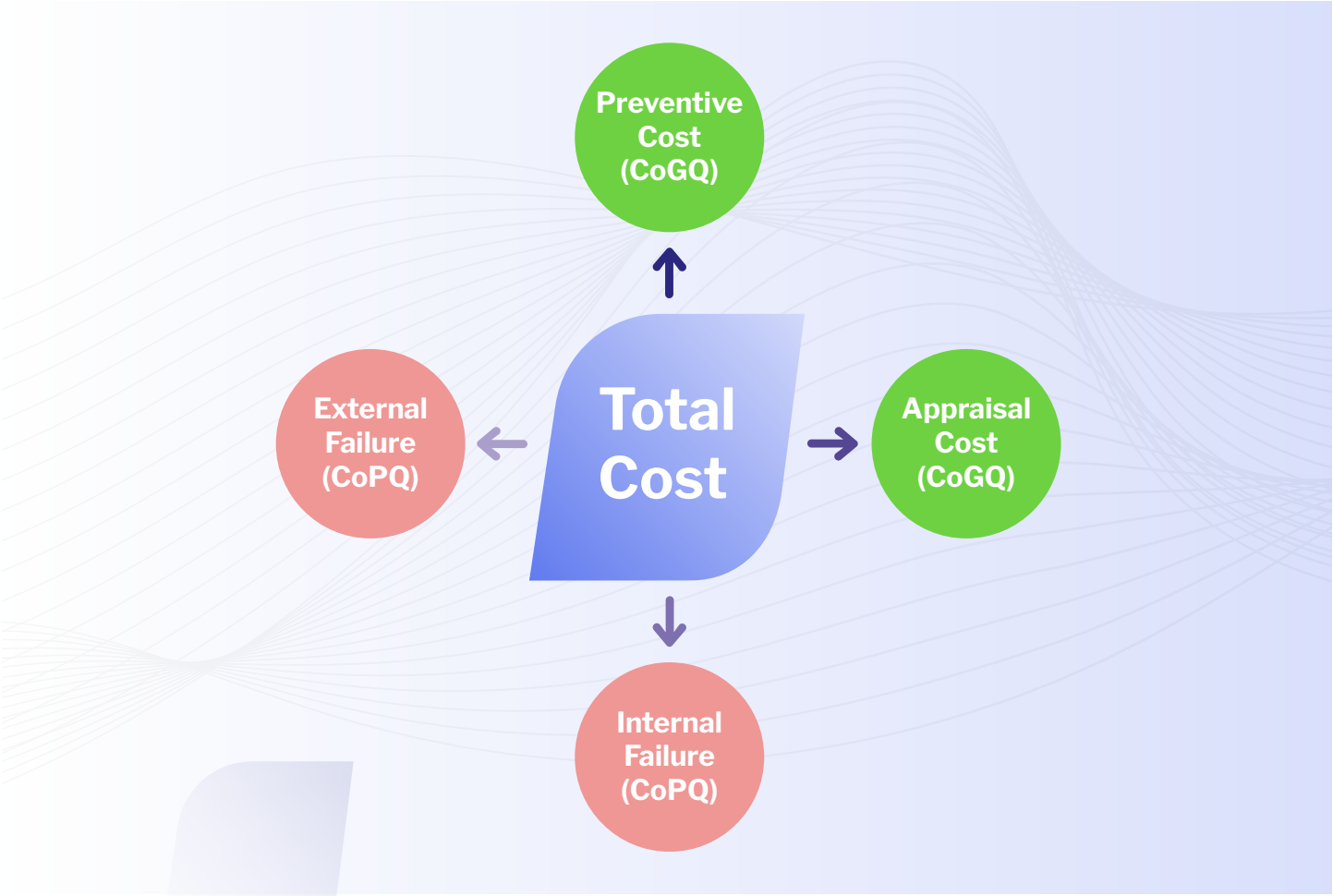
performance of each quality activity in terms of costs. The development of an effective quality management system is possible when the exact causes of failure costs are analyzed to determine preventative measures suitable for each organization's specific environment.

What is the Cost of Quality (CoQ)?

The cost of quality defines and measures how much of a company's resources are associated with prevention activities and maintaining product quality instead of costs resulting from internal and external failures. Two factors determine the Cost of Good Quality (COGQ) and the Cost of Poor Quality (COPQ). The Cost of Good Quality (COGQ) encompasses all costs associated with quality conformance. In contrast, the Cost of Poor Quality (COPQ) includes all the non-conformance costs that are internal and external to the company.

CoQ = CoGQ + CoPQ

The Cost of Quality considers all associated costs with the quality of a product. These costs include preventive costs intended to reduce failures, the cost of process controls to maintain quality levels, and the costs related to internal and external failures.



Deciphering CoQ: Taking a Holistic Look at Hidden Cost

As calm as a duck appears above water, beneath the surface, it must paddle hard to remain afloat. This observation can be applied to the cost of quality as it represents the percentage of an organization's total capacity or effort used to overcome the cost of poor quality. Nonconformance, failures, and defects within businesses constitute the cost of a Poor-Quality system. It applies to the food and beverage industry and other services sectors. Companies report the cost of poor quality (internal and external failures) as a portion of their annual revenue or total costs. Several quality tools (PAF model) measure and manage these costs to drive continuous improvement and strategic project selection. Uncovering hidden costs will depend on the proficiency of an organization in identifying poor-quality cost drivers. Identifying and accounting for all hidden activities or costs can be challenging. Manufacturing operations can include labor, time, resources dedicated to reworking, re-processing, or re-inspection, the space in your warehouse dedicated to storing non-conforming products, etc. It is not uncommon for significant quality costs to be overlooked or unrecognized simply because the design of most accounting systems cannot identify them. Failures arise from events or incorrect process execution that negatively affect the finished product. Internal failures are usually discovered and corrected before the product or service reaches the customer.

In contrast, external failures are identified and rectified downstream of the supply chain and may involve the customer. External failures are typically more costly and complex to resolve than internal failures due to the involvement of customers or third parties. The avoidance of a non-conformance helps eliminate waste associated with correcting the non-conformance.

HIDDEN COST ACTIVITIES

Extra Material Handling

Product Rework

Labor losses

Root cause

Lost equipment time

Legal fees

Customer Complaints

Lost Customers

Excess Overtime

Implementing a CoQ Financial System

Utilizing and implementing the Cost of Quality methodology enables an organization to efficiently quantify the resources it uses for Cost of Good Quality and Cost of Poor Quality. This information allows for the effective reallocation of resources to improve product quality.

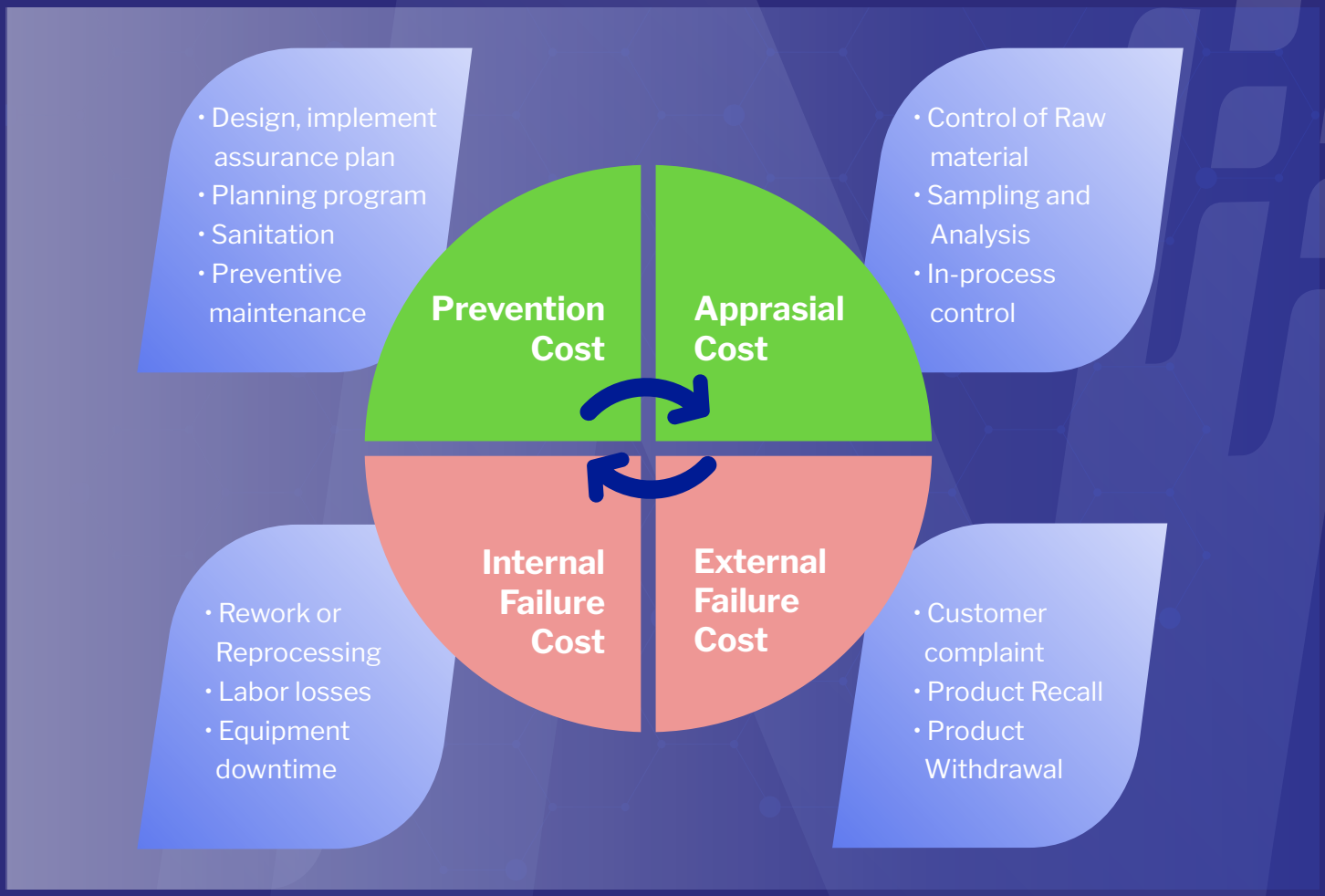
A Cost of Quality approach improves product quality while reducing costs. It provides detailed information, such as how to evaluate the performance of quality systems, identify problem areas, and leverage opportunities successfully. The most effective way to show the benefits and value of integrating the CoQ system is to start with a Pilot program. The initiation of a pilot program provides actual data enabling the verification that a quality system would benefit the company.

The following strategies below will guide in the incorporation of a pilot program:

DEFINE YOUR COST OF QUALITY CATEGORIES

The Cost of Quality consists of four categories: Prevention Cost, Appraisal Cost, Internal Failure, and External Failure. Establishing your quality cost categories can assist you in developing a consistent and accurately categorized CoQ program for your company, preventing the exact costs from fluctuating over time between categories and compromising the integrity of your data.

Quality Categories



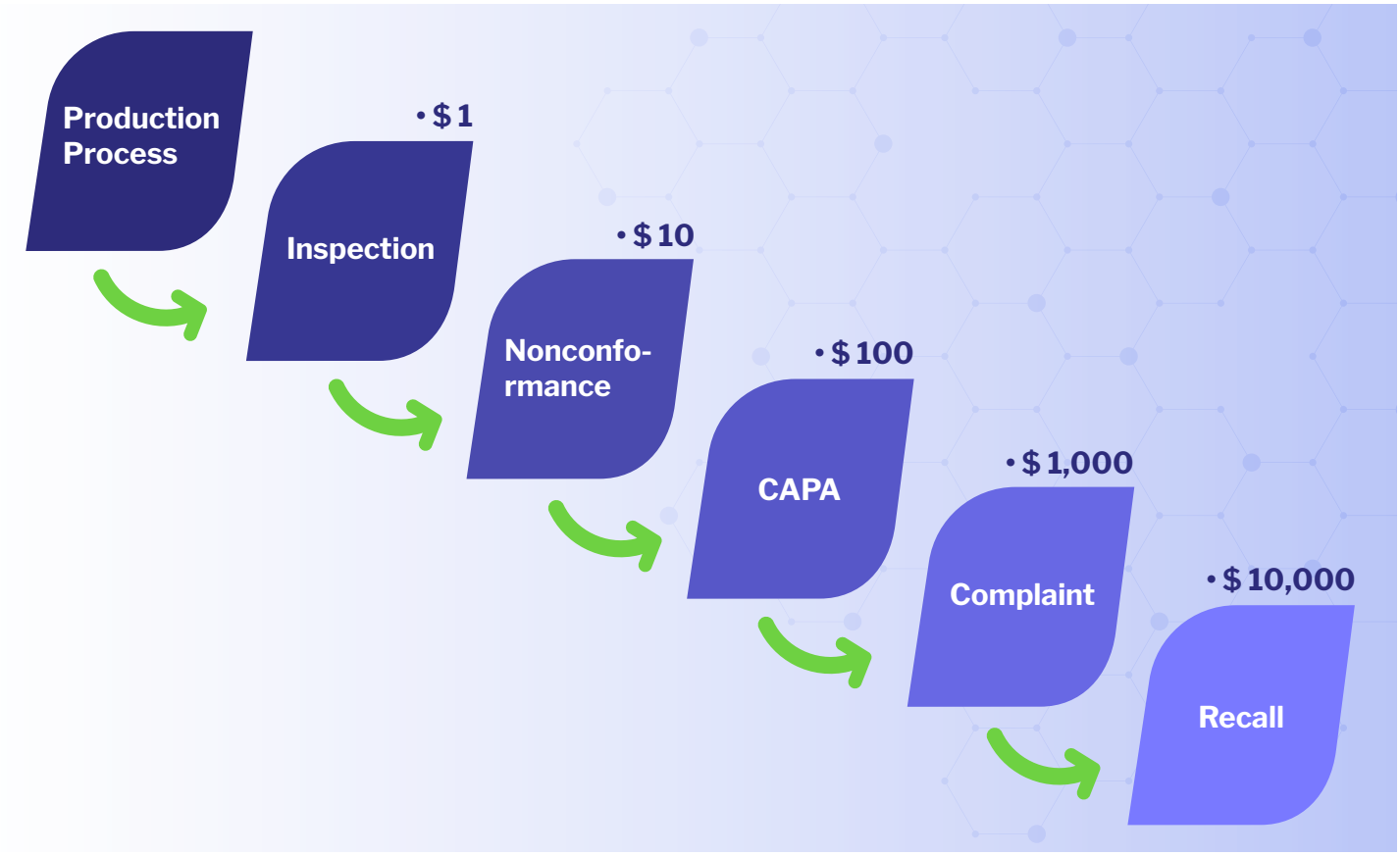
> **A preventive action investment provides the highest return on investment, as the costs associated with non-quality increase exponentially as the product moves from manufacturing to distribution and finally to the end user.**

The general rule of thumb of 1/10/100 means that compared to prevention activities that cost 1 dollar, the result of poor quality:

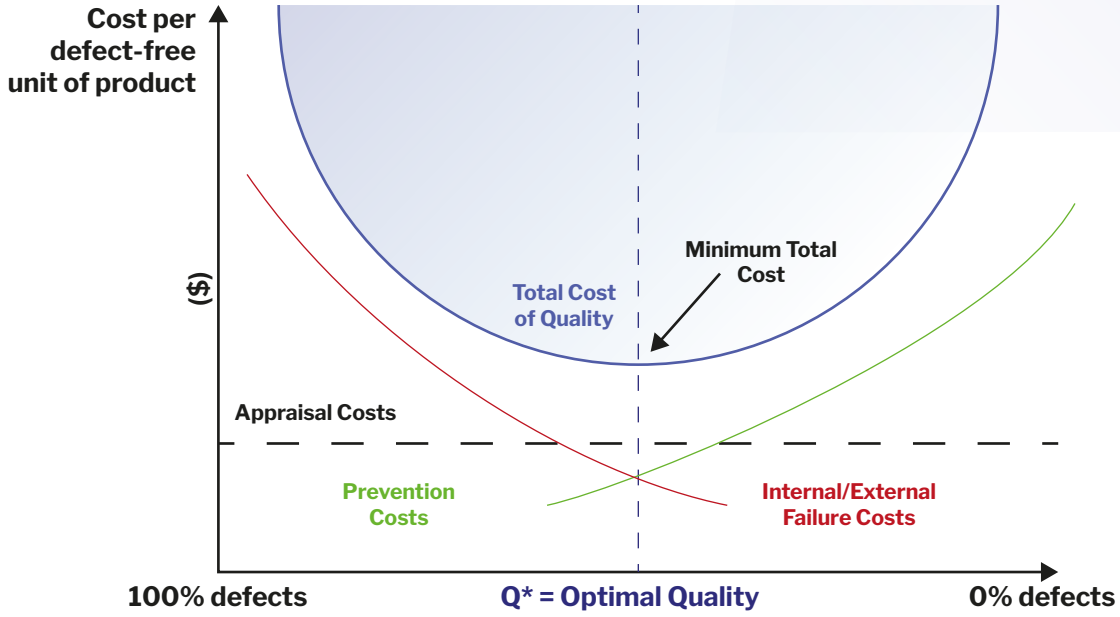
- is 10 times costlier when identified during appraisal activities and internal failure.
- is 100 times more expensive when recognized after product distribution.

It usually is less costly to detect non-conformance at an earlier stage.

The cost associated with an error increases as we move along the value chain.



THE COST OF QUALITY CURVE



It is critical to understand the relationship between the cost of conformance and the cost of non-conformance. The CoQ curve above illustrates this; the X-axis represents the Quality level. The Prevention & Appraisal Costs increase linearly as conformance increases from 0% to 100%. Similarly, the Failure Costs (Internal + External) begin decreasing sharply. In addition, the Total CoQ (Cost of Quality), which is the sum of these two other curves, also reduces dramatically. A conformance level of 100% has the lowest Total CoQ; at this point, the Total CoQ equals the Cost of Prevention & Appraisal. Understanding the actual costs of internal and external failure is crucial to formulating a CoQ for your company. Investing appropriately in prevention and appraisal methods can help mitigate those risks. A cost avoidance strategy serves as an insurance policy. You can determine if it hurts or helps your business by adding up the costs associated with your food safety and quality efforts. In other words, you pay for the cost of prevention and detection to ensure optimal quality performance of your processes.

DEFINE DATA GATHERING TECHNIQUE AND COLLABORATE WITH KEY STAKEHOLDERS

- Once you've harmonized the categories associated with your data, the next step involves standardizing the data collection method for each type and specifying different data sources for each category.
- Determine which individuals or departments within the organization are affected by these categories & data sources, and cooperate with key stakeholders, communicating data gathering delegation. Collaborate closely with your financial or accounting department to ensure the utilization of credible sources and data collection methods.

GATHER, ANALYZE, AND REPORT QUALITY COST DATA TO DRIVE IMPROVEMENTS

- The data gathered should reflect the actual costs or the measurement base, such as the percentage of sales, quality costs, the portion of the cost of goods manufactured, or the relative number of units produced.

Engaging in a pilot program aims to drive continuous improvement and strengthen the quality attributes of the company.

The Opportunity Cost of Poor Quality

Poor quality indicates a deviation from the plan for running an efficient production system that produces only marketable products. Whenever a company deviates from its planned activities, it incurs opportunity costs. As a result of poor quality production, opportunity costs exist – as the company cannot devote all its time and resources to activities that add value. Thus, the manufacturer misses out on opportunities to produce and sell high-quality output, resulting in a loss of profits.

Traditionally, the value of lost opportunities is not included in traditional accounting because the true cost development for alternative solutions appears unpredictable during decision-making.

Consequently, opportunity costs have a tangible impact on the organization. In addition, there is a direct correlation between quality improvements to an increase in sellable products through a reduction in defect rates. The market's capacity to support growing sales volumes has measurable and predictable implications for profit. Even without increasing sales volumes, reducing the cost burden on one product may be possible.

THE EFFECT OF QUALITY ON PRODUCTIVITY – MISSED OPPORTUNITIES

Productivity measures the output a production process can generate given a certain amount of variable inputs. This relation in a production function represents the maximum possible output a company can manufacture from a given level of variable inputs and constitutes a point in this function. Let's consider a food canning producer with regular variable costs of $5 per can based on a production volume of 1,000,000 cans per year. Due to an 18% defect rate, only 820,000 instead of 1,000,000 cans are of a quality suitable for sale. While the inputs have cost the company five million

dollars, the output is less than the initial target of one million cans. As a result of the wasted inputs, the cost of a good quality canned product has increased to $6.10. Consequently, the single can price has increased by $1.10, or 22%, compared to the original estimate, affecting profit margins.

Example

J. Doe Canning Company

Total Production Volume:	1,000,000
Defect rate:	**18%**
Variable production cost per can	$ 5.00
Variable production cost per 1,000,000 cans	$ 5,000,000
Unsellable quantity due to poor quality = 1,000,000 x 0.18 =	820,000 cans
Variable production cost per can for a defect rate of 18%: $5,0000,000 ÷ 820000 cans =	$ 6.10
Increase in variable production costs per tablet for a defect rate of 18%: $(6.10 ÷ 5.00) – 1 =	**22%**

THE EFFECT OF QUALITY ON CAPACITY – MISSED OPPORTUNITIES

In process manufacturing, Fixed production costs primarily arise from production facilities and management overhead. They are the most crucial cost components independent of the volume produced. In many ways, they represent the essential elements of our production capacity – machines and space are equally critical to the fabrication of products, as is the management necessary to coordinate complex and interconnected processes. Knowledge of overcapacity in food and beverage industries confirms that installed production capacity utilization is inefficient. The trigger for overcapacity stems from several reasons, including declining demand or exaggerated industry expectations, but a more prominent cause is poor quality. An inferior quality product also translates into wasteful utilization of the planned capacity.

The impact of overcapacity is evident in the manufacturing process as it affects the ability to use existing capacity due to congestion from defective, poor-quality products. Quality-induced overcapacity leads to the inability to produce a planned level of sellable products. In addition, quality problems cause production distortions that result in operational breakdowns. The constraining effects of poor quality permeate across the organization, from quality personnel to management, hindered by the challenges of dealing with quality issues. A sizable proportion of the available management time has to be allocated to planning and coordinating efforts to address the quality problem, and time dedicated to actual strategic purposes declines.

Improving quality will lead to production proficiency and management freedom from the burden of firefighting non-conformances. Since the potential sale volume is the same for a high-quality and a low-quality product, the latter must have a larger production capacity to achieve the same sales.

How to Strategically Reduce the Cost of Quality

Cost trade-offs exist between the amount of money an organization spends on prevention and fixing failures. Traditionally, reducing the number of defects has been viewed as an effective method for reducing the cost of quality. One way to reduce the cost of quality is to improve the efficiency of the processes for handling preventions and failures. It would be prudent to reinvest the savings realized from enhancing the performance of quality management processes and reducing the costs of failures (cost of processing a non-conformance, cost of inspection through automation). The allocation of gained savings into better prevention methods, such as more accurate machines, better tooling, and more training, would result in even higher levels of quality and will foster a continuous improvement culture.

GOING BEYOND STATISTICAL PROCESS CONTROL

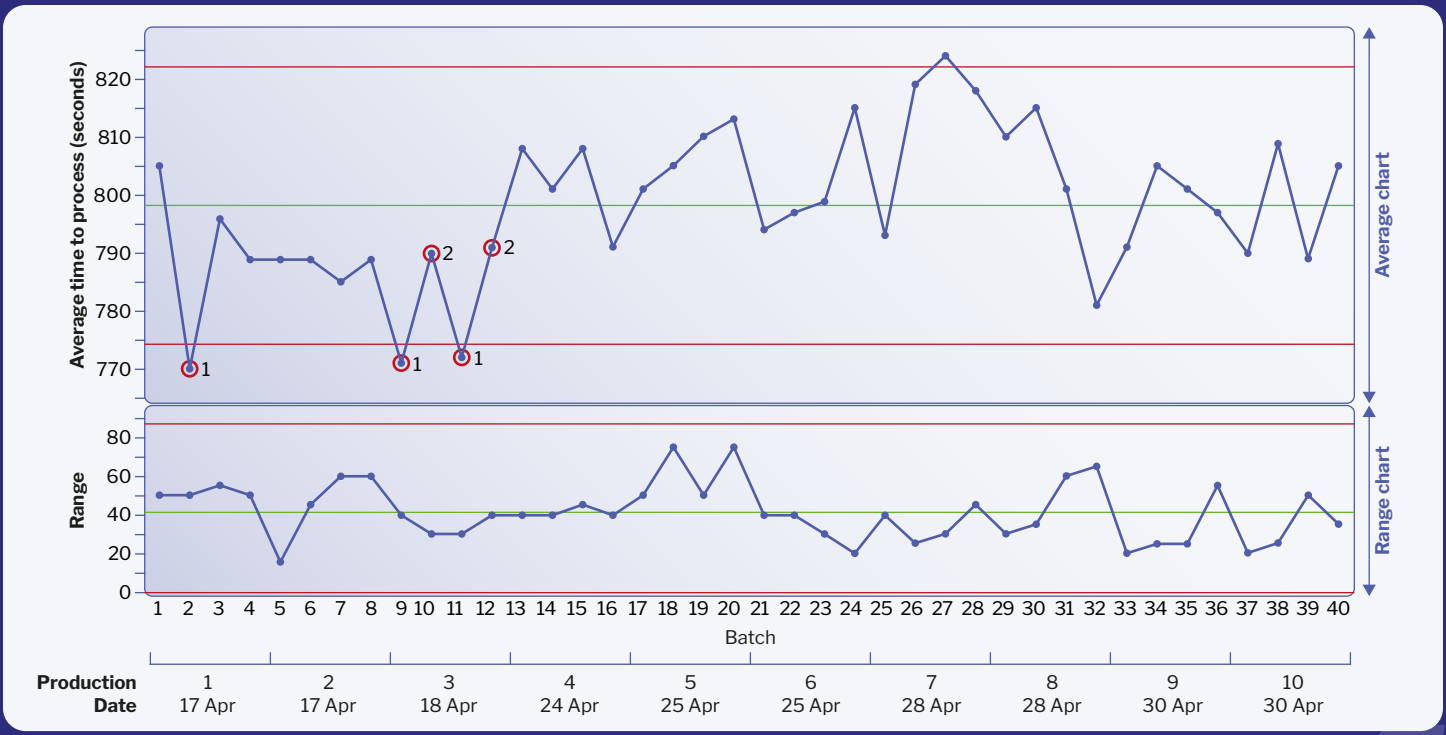
The F & B industry must evaluate the Cost of Quality (CoQ) beyond Statistical Process Control (SPC) and assess the whole process through scientific, regulatory, and statistical lenses to achieve a competitive advantage within the modern marketplace. The utilization of analytical approaches such as control charts, capability analysis, and statistical process control in analyzing quality metrics during the food production process has assisted companies in gaining valuable insights into the conformity of the products they produce. A control chart illustrates the predictability of a process by plotting and chatting data, indicating stability within that process. By performing a capability analysis, food and beverage companies can evaluate whether a system can meet specific requirements. The implementation of Statistical Process Control allows companies to analyze and interpret data to identify improvement opportunities. This process may involve gathering data regarding any fill rates in food packaging or potential food-borne pathogen incidents within the production process; it is possible to measure and improve any process.

For example, during a production review meeting at a beverage manufacturing company, in-and out-of-specification data were presented on time to process screw caps. The specification data indicated that all screw caps produced over a 10-day production timeframe were satisfactory. However, when the statistical team analyzed the production data using SPC (control charts), they realized that process was unstable over time, indicating that the current process could operate with a narrower level of variation. Detecting this variation would have been hard using traditional data gathering methods. Implementing SPC enabled the statistical team to improve their process by highlighting the presence of process variance within the screw scrap production process.

Below is a summary of the presentation report–

Time to process Screw caps

Number of measurements	In specification	Out of Specification	Status
20,000	20,000	0	**Okay**



Several models serve as a scientific framework for quality costing, namely P-A-F (prevention, appraisal, and failure), Process cost models, Crosby's models, Opportunity cost models, ABC models, and Taguchi loss functions. The P-A-F Model is the most accepted model for quality costing and categorizes costs under three classifications – Prevention, Appraisal, and Failure Costs. It captures all the costs related to the quality system, the inspection of products, and the sustained costs when the product fails to meet the requirements.

A science-based approach integrating machine learning and process control algorithms into the quality management process is of tremendous value to the food and beverage industry. Machine learning techniques entail modeling the relevant production processes and assets in a production line, followed by applying the appropriate machine learning algorithms in the manufacturing process and product context. A framework for self-optimization with minimal human involvement is provided by recognizing data patterns and anomalies from standard behaviors and historical deviations. This allows manufacturers to preemptively forecast quality and safety risks and thus take timely and targeted countermeasures to mitigate them. Machine learning can increase nonconformance detection rates by as much as 90% while reducing the time it takes to identify the root cause of quality issues from days to minutes. Food and beverage manufacturers will be able to significantly improve the overall effectiveness of their equipment and improve the efficiency of their lines to reduce their time to market by utilizing machine learning. By implementing machine learning, companies can monitor machinery and product data throughout the manufacturing process to predict quality defects before their occurrence. Teams responsible for quality and maintenance are alerted to the exact causes of anticipated defects. By integrating machine learning into the quality management process, food

and beverage companies will improve their brand reputations by minimizing product recalls and increasing customer experience. Companies stand to gain noticeable reductions in quality issues, waste, manufacturing costs, and quality costs that plague the industry.

REDUCING CoQ THROUGH QUALITY MANAGEMENT SYSTEM (QMS)

A cost-of-quality analysis aims to reduce the cost of poor quality and sound quality without lowering the quality of your product. The use of a Quality Management System (QMS) will result in a significant reduction of both types of costs, as it will dramatically improve workflow efficiency as well as provide detailed information about any potential risks or waste during the production process. Deploying a QMS would be categorized as appraisal costs. When accounting for quality management software, note the time savings achieved in your organization utilizing the software solution.

The following examples show how a quality management system can help you lower your quality costs:

- **Faster problem solving**
  There is no need to put out fires continuously. It is crucial to address adverse issues before systemic issues develop to reduce costs. A review of the most prominent recall cases in recent years shows that the most expensive problems are those caused by ineffective management at the outset. The adoption of a quality management system provides a systematic approach to problem-solving. Taking this step reduces quality costs by preventing recurrences.
    - **Automation of Corrective and Preventive Action (CAPA) processes:** Through the review and analysis of root causes and actions, a QMS keeps corrective actions moving forward to ensure that problems do not remain undetected.
- **Change Management Tools**
  In today's economy, you must adapt to the changing market. Companies may find it challenging to maintain agility due to the sheer cost of any proposed change. The use of a quality management system reduces uncertainty. In addition, it links related processes such as employee training and document control.
- **Controlling risks effectively**
  Making risk-based decisions is at the core of continuous improvement. It is essential to manage risk effectively to reduce quality costs. Using a quality management system, you can incorporate risk analysis tools into any process, including bowtie analysis, decision trees, and risk matrices. Using it, you can assess whether your efforts have reduced risk to an acceptable level.
    - Managing audits
    - Compliance with Legal and Regulatory Requirements
    - Centralized Record keeping

Conclusion

By performing a CoQ analysis, companies can compare and evaluate quality categories (prevention, appraisal, and failure costs); they will be able to determine whether the allocation of quality costs within their organization is appropriate. In addition, it provides valuable data that facilitates the achievement of company objectives, such as defining budget goals and identifying profit-making opportunities.

Every process manufacturing organization should use the cost of quality analysis to identify high-cost areas that lead to failures. It is important to remember that every failure has a cause and uncovering the reasons behind its occurrence requires due diligence and cross-functional support.

Fewer costs are associated with failures detected at the beginning of an operation. It is advisable to prioritize prevention costs to minimize costs, as preventing defects is more cost-effective than correcting them. Reducing the cost associated with prevention and appraisal, in turn, diminishes the total cost of quality. The cost of quality action team must concentrate on finding the root cause of a problem, develop corrective action, and employ permanent solutions to decrease the cost of quality.

KEY TAKEAWAYS

- External factors, such as inflation, sustainability concerns or regulations, will be impacting the CoQ in 2023
- A CoQ approach enables an organization to efficiently quantify the resources it uses for CoGQ and CoPQ, allowing for the effective reallocation of resources to improve quality and reduce costs
- Compared to prevention activities, the result of poor quality is:
  - 10x costlier when identified during appraisal activities
  - 100x more expensive when recognized after product distribution
- The combination of science-based approaches and digital solutions can significantly reduce the overall CoQ

Founded in 2012, Novolyze empowers food and beverage companies to enhance food safety and quality performance through digitalization. The company was created with the ambition to invent a novel way to envision food safety and quality, which relies less on finished product testing and leads to superior positive impacts in environmental sustainability, yield, and production. Novolyze offers comprehensive solutions that leverage digital transformation with exclusive food safety products and services, to reduce water and energy usage and carbon footprint while ensuring compliance and product safety and quality.

Over 20 of the world's top 100 food companies now use a Novolyze solution or product to help mitigate risks, ensure compliance, augment plant performance, and increase sustainability.

Are you ready to find out more?

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