

# Reducing the Cost of Quality in Electronics Manufacturing

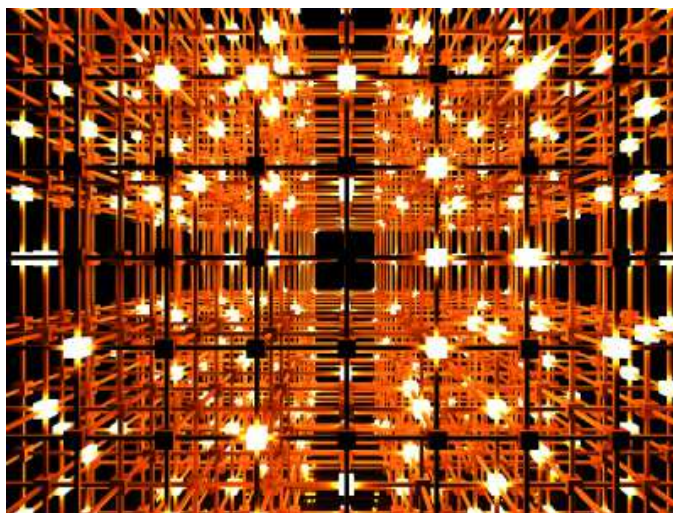


Because the electronics manufacturing industry is incredibly competitive, players are constantly looking for the edge that can push them to the front of the pack. Recent research by LNS has shown that many of these companies are looking towards measuring the cost of quality as an avenue toward creating this differentiation. In this Research Spotlight LNS will highlight the market drivers impacting electronics manufacturers today, provide a technology roadmap for addressing these issues through measuring the cost of quality, and share recent benchmark data that shows the benefits some market leading companies have already enjoyed.

## Electronics Industry Overview

The electronics industry can be thought of in three distinct supply-chain nodes or sub-vertical industries, including semiconductors, electronics manufacturing services (EMS) or contract manufacturers, and original equipment manufacturers (OEM). For the purpose of this paper, we will focus EMS vendors and smaller contract manufacturers. Along the supply chain, EMS vendors, or electronics manufacturers, can be thought of as middle-tier, having a customer relationship with semiconductor producers as well as a supplier relationship with OEMs.

Ranging from multibillion dollar operations to smaller contract shops, electronics manufacturers typically design, manufacture, assemble, test, and distribute electronic components and printed circuit boards (PCB) or carry out a combination of those functions in house. For both small and large



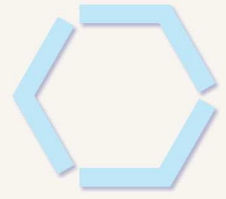
operations, customers are generally large, powerful, and demanding, coming from regulated and unregulated industries such as Automotive, Medical Devices, Aerospace and Defense, Industrial Equipment, and more.

## *Challenges Faced by Electronics Manufacturers*

The dynamic nature of the industry creates a distinct set of challenges for electronics manufacturers. Impacting business processes across the value chain, these challenges drastically increase the level of competition for both small and

"Right now our company has a gap between executive management and the shop floor regarding the importance of quality and software systems. By measuring the Cost of Quality we hope to put operations and quality in a language they understand, dollars and cents."

*~Operations Manager, Small Electronics Manufacturer*



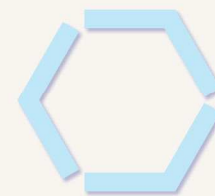
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large players. It is how these challenges are addressed and overcome that differentiates market leaders from the rest of the industry.

- **Shrinking Operating Margins:** With the continual rise of the global supplier network, the electronics manufacturing industry is more competitive than it ever has been before. Pressures for large and small players in the U.S., Europe, Mexico, and Asia are increasing as nations such as China drive prices down. Electronics manufacturers have to balance the ability to remain competitive in costing with maintaining a high level of quality.
- **Complex Supply Chains:** Leveraging the global supplier network is a requirement for many industries today where cost is a main challenge. This is no different for electronics manufacturers. In many cases, however, IT capabilities as well as quality and compliance standards may not parallel customer expectations. With such a highly competitive industry, electronics manufacturers must have the capability to validate supplier activities with upstream visibility into traceability and the quality of products.
- **Service and Warranty Management:** Electronics manufacturers that attempt to capitalize on the global supplier network to improve operating margins face many risks. Without strong upstream quality and traceability tools in place, issues can surface in service and warranty management. The corresponding increase in warranty reserves and use of service can affect both profitability and reputation in the marketplace. Electronics manufacturers need the capability to trace defects back to their origin in the value chain.
- **Short Product Lifecycles:** Because customer preferences can change quicker than most industries, electronics manufacturers need to optimize new product introduction (NPI) cycles. A main challenge that emerges with NPI is in having integrated IT and processes across the value chain. Engineering, manufacturing, and other areas need tools that allow for cross-functional communication and collaboration to effectively enhance current product lines and introduce new products to the market.
- **Sustainability/Regulatory Compliance:** For years, laws and regulations have been becoming stricter in the electronics industry. For example, in the European Union, REACH, RoHS, and the WEEE Directive have been passed to help protect the environment and validate that organizations are complying with certain sustainability-related standards. There is increasing pressure for electronics manufacturers to take a sustainability perspective in the product lifecycle, including the environmental impact of products after disposal.

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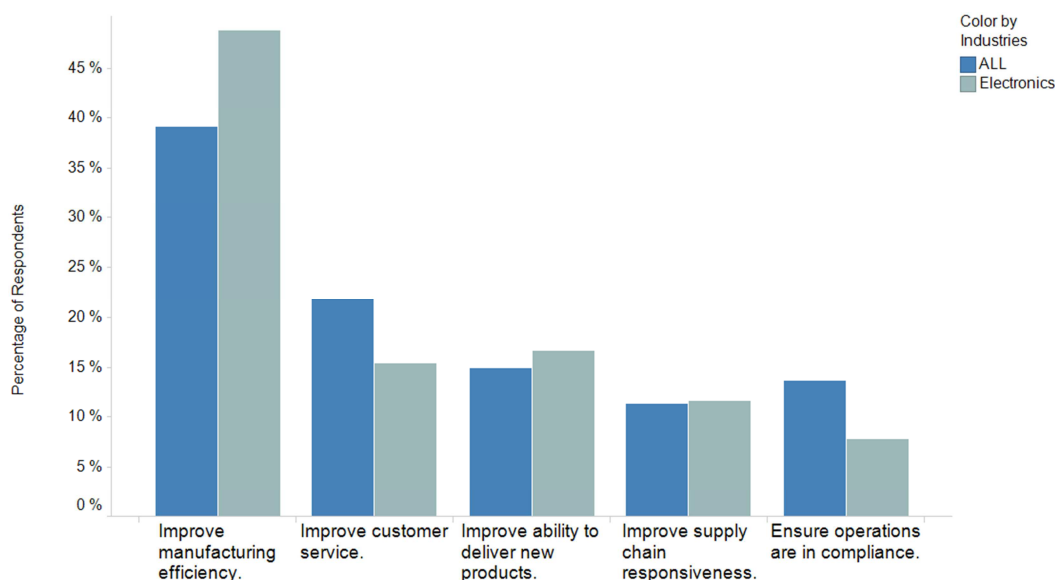
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#### Top Operational Objectives

Electronics manufacturers face a unique set of challenges and market drivers, around which executives set operational objectives. To highlight executive focus areas in electronics manufacturing and put their operational objectives into perspective, it is helpful to view them alongside executives from other industries. LNS Research's 2012-2013 quality management survey benchmarked nearly 400 companies. One of the first questions asked was "Which operational objective will receive the most executive attention in 2012?"

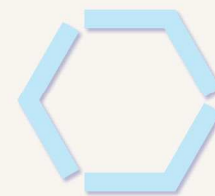
Figure 1: Top Operational Objectives



Manufacturing efficiency, lean production capabilities, and seamless transition between critical business processes is required in such a competitive marketplace.

As show in the chart above, a significant number of respondents, 49%, from the electronics industry stated that their organizations were focusing on improving manufacturing efficiency. This response rate is considerably higher than the aggregate from the rest of the industries for "Improve manufacturing efficiency." What is also interesting is the second highest response for the electronics industry is "Improve ability to deliver new products," an objective closely tied to manufacturing efficiency as well as other important industry drivers mentioned above.

With the challenges and market drivers faced by electronics manufacturers such as shrinking operating margins, short product lifecycles, and uncertain demand, it is not surprising that manufacturing efficiency is the top operational objective noted by executives. Manufacturing efficiency, lean production capabilities, and seamless transition between critical business processes is required in such a competitive marketplace.



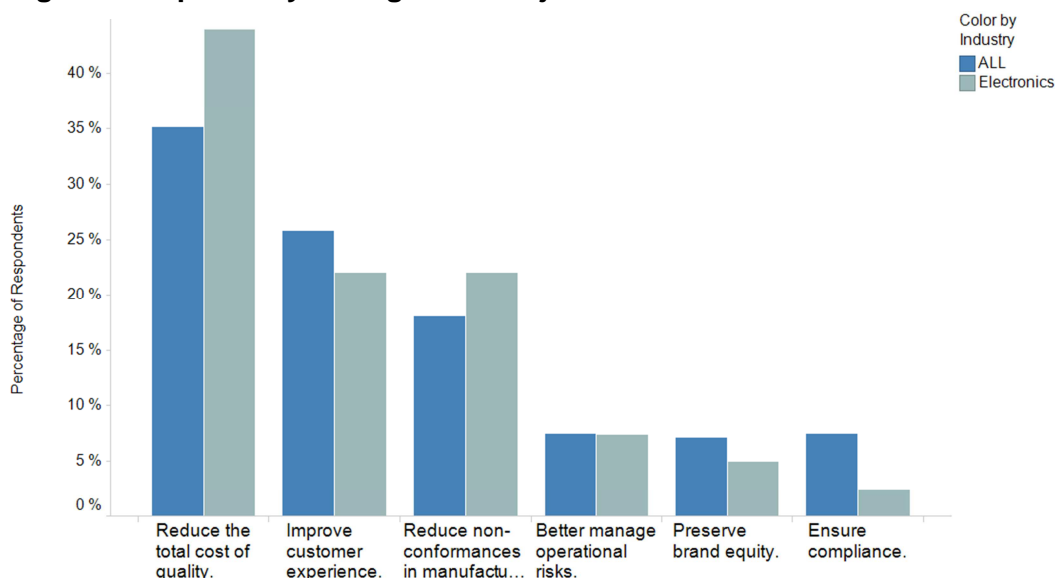
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#### *Top Quality Management Objectives*

It is important to understand that the operational objectives discussed above should not be viewed in a vacuum. Rather, within a company, they are commonly in harmony with other operational objectives and the broader set of strategic objectives, which can be quality-focused, financial, and environmental in nature. For quality, LNS Research's 2012-2013 quality management survey asked a similar question to the one above, "Which quality management objective will receive the most executive attention in 2012?"

**Figure 2: Top Quality Management Objectives**

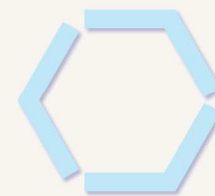


The cost of quality metric is a complex and holistic business measurement that provides in-depth data on the quality of products and processes. Its sub-variables can be inspected closely to provide granular visibility into the effectiveness and efficiency of business processes.

Depicted in the chart above, an overwhelming number of respondents from the electronics industry chose reducing the total cost of quality as their top quality management objective. With such importance placed on manufacturing efficiency, this quality management objective is perfectly aligned. The cost of quality metric is a complex and holistic business measurement that provides in-depth data on the quality of products and processes. Its sub-variables can be inspected closely to provide granular visibility into the effectiveness and efficiency of business processes.

#### *Top Quality Management Challenges*

Supporting the previous two data points, when asked which quality management challenge executives would be most focused on in 2012, a majority of electronics industry respondents from the 2012-2013 Quality Management Survey said effectively measuring quality metrics. As shown in Figure 3, aggregate responses



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across all industries were similar. There seems to be a consensus that quality management metrics are vital to success.

**Figure 3: Top Quality Management Challenges**

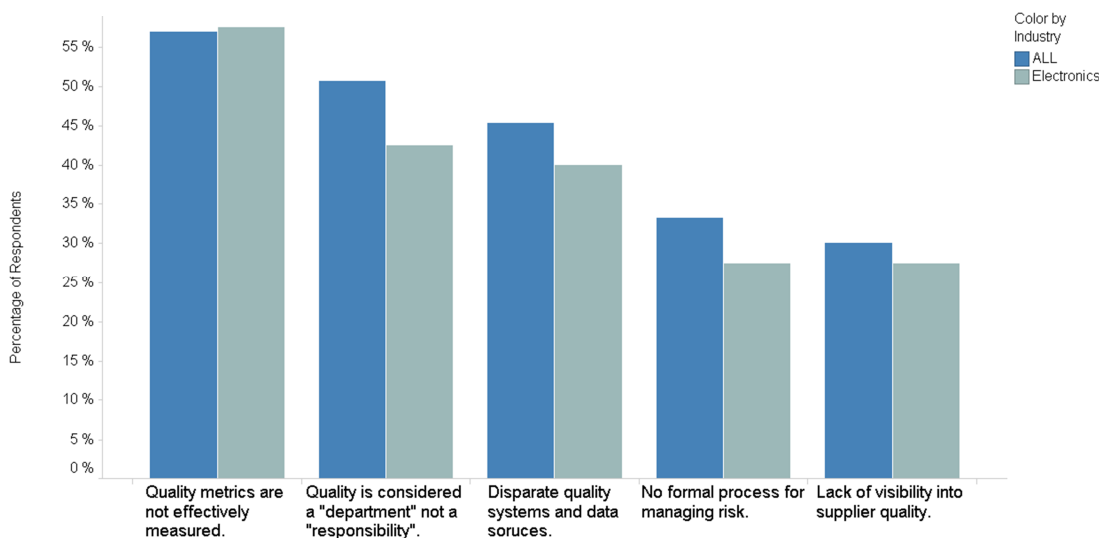


Figure 3 supports the notion that companies across all industries have a strong focus on and interest in delivering high quality products and processes. It also shows that companies are having difficulty with understanding how to use metrics effectively as well as with utilizing tools and emerging technologies to streamline quality data to the executive metrics dashboard.

Most commonly, organizations measuring the cost of quality will focus on the costs incurred from defects in products and processes or other rework-related issues. This, however, is only part of the overall equation.

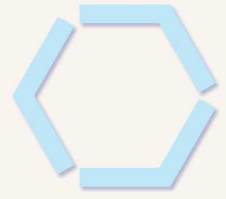
## Defining the Cost of Quality

The cost of quality measures the costs incurred in delivering high quality products and processes. Although it is a metric that many organizations utilize, it is typical for there to be disparities in the actual equation and variables used for calculating it. Most commonly, organizations measuring the cost of quality will focus on the costs incurred from defects in products and processes or other rework-related issues. This, however, is only part of the overall equation.

There are two main elements to focus on to effectively make use of the cost of quality's effectiveness as a holistic business measurement: the Cost of Good Quality (CoGQ) and the Cost of Poor Quality (CoPQ). The CoGQ relates to costs incurred to assure the quality of products and prevent poor quality. The CoGQ should be viewed as an investment in reducing the CoPQ, whereas the CoPQ can be viewed as a direct measurement of the failure costs incurred in producing a product. Together, these two variables make up the cost of quality.

$$CoQ = CoGQ + CoPQ$$





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Market leading organizations measuring the cost of quality are breaking these two variables down to a granular level. The CoPQ measures internal and external failure costs and the CoGQ measures appraisal and prevention costs. The following section will cover these two variables more in depth.

#### *The Cost of Poor Quality*

The CoPQ quantifies traditional quality costs companies measure. These costs typically include rework, scrap, and returned materials and originate both internally and externally. Because they can come from the production line as well as activities in the supplier network, it is important to differentiate these costs by breaking down the CoPQ variable into two sub-variables: Internal Failure Costs (IFC) and External Failure Costs (EFC).

$$\text{CoPQ} = \text{IFC} + \text{EFC}$$

$$\text{Internal Failure Costs (IFC)} = \text{Scrap Costs} + \text{Rework Costs}$$

$$\text{External Failure Costs (EFC)} = \text{Returned Product Costs} + \text{Warranty Costs} + \text{Product Recall Costs}$$

#### **Factors Affecting IFC**

- Weaknesses in quality resolution (CAPA/FMEA)
- Delayed work schedules
- Poor Materials Planning
- Materials shortages
- Equipment downtime
- Materials review
- Reengineering/redesigning products

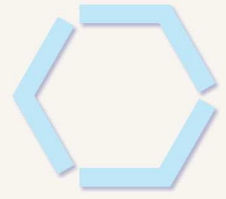
#### **Factors Affecting EFC**

- Poor service management
- Unresolved customer complaints
- Weak enterprise communication
- Environmental/sustainability nonconformances
- Adverse reputation events

#### *The Cost of Good Quality*

On the other end of the spectrum, the CoGQ measures costs related to areas such as people and technology involved in the production of high quality products. These costs are much less likely to be accounted for by executives and plant

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managers in respect to the cost of quality equation. They are often measured disparately rather than in a standardized way that can facilitate enterprise-wide comparison. The CoGQ has two central components: Appraisal Costs (AC) and Prevention Costs (PC).

$$\text{CoGQ} = \text{AC} + \text{PC}$$

*Appraisal Costs (AC) = % of labor, software, and equipment costs focused on appraisal activities*

*Prevention Costs (PC) = % of labor, software, and equipment costs focused on prevention activities*

#### **Appraisal Cost Components**

Associated with measuring, evaluating, and auditing products or services, appraisal costs generally assure conformance to quality standards and performance requirements. Activities that fall into this category include inspections, testing, and calibration. To effectively measure these costs, it is helpful to break them down into three broad categories: employee costs, software costs, and equipment costs. This allows executives and managers to appoint a percentage to each cost in relation to total revenue.

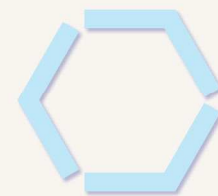
#### **Prevention Cost Components**

Preventive cost measures the costs associated with activities designed to prevent poor quality in products or services. Activities that fall into this category include quality planning, risk management, continuous improvement team initiatives, corrective and preventive actions, and audit management. Similar to appraisal costs, preventative costs can be broken down into three broad categories, employee costs, software costs, and equipment costs, and measured as a percentage of total revenue for comparison.

### **Benchmarking the Cost of Quality**

Leveraging benchmark data is an excellent way for executives to understand how their organization compares to others within their industry as well as between industries. Market leading companies are using benchmark research to strengthen the perspective of both current performance on key metrics and progress toward long-term goals. It is important to choose a method for measuring the cost of quality, such as the one described above, and making it the corporate standard for the entire enterprise. This greatly facilitates the task of benchmarking.

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Attaining benchmark research on the cost of quality is difficult, which is why LNS Research made it a focus for the 2012-2013 Quality Management Survey. Because there is no single equation that is the standard for all industries and organizations, methods used for measuring the cost of quality can vary significantly by company. Moreover, it may be possible for there to be multiple methods for measuring the cost of quality within an individual organization. This could stem from a lack of communication between distributed facilities or lines of business.

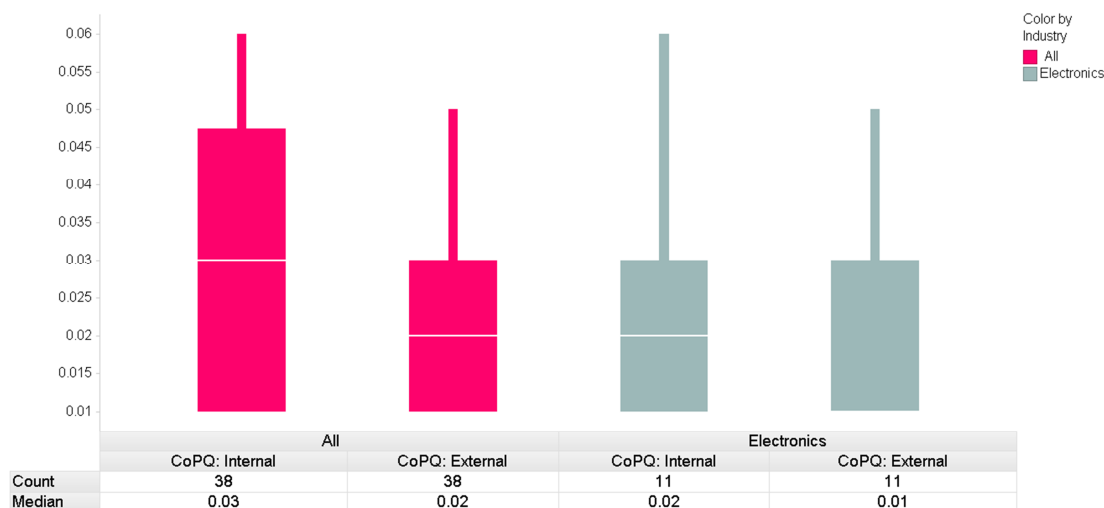
LNS Research's 2012-2013 Quality Management Survey executives were asked to quantify the cost of quality as a percentage of total revenue. This helps to reduce disparities between different equations. The survey looked at four main variables of the cost of quality: appraisal costs, preventative costs, internal failure costs, and external failure costs. These four variables make it easier to compare and contrast the effects of people, processes, and technology on the quality of products and processes.

#### *Cost of Poor Quality Benchmark Data*

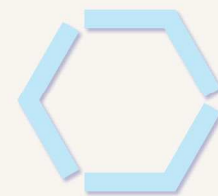
Respondents from the 2012-2013 Quality Management Survey were asked to provide information on the cost of poor quality. Figure 4 shows electronics manufacturers are outperforming other industries with the bottom two quartiles in both IFC and EFC at or below 3% of total revenue. Electronics manufacturers are performing well in terms of failure costs incurred in the value chain.

Because there is no single equation that is the standard for all industries and organizations, methods used for measuring the cost of quality can vary significantly by company and even within companies/

**Figure 4: Cost of Poor Quality**







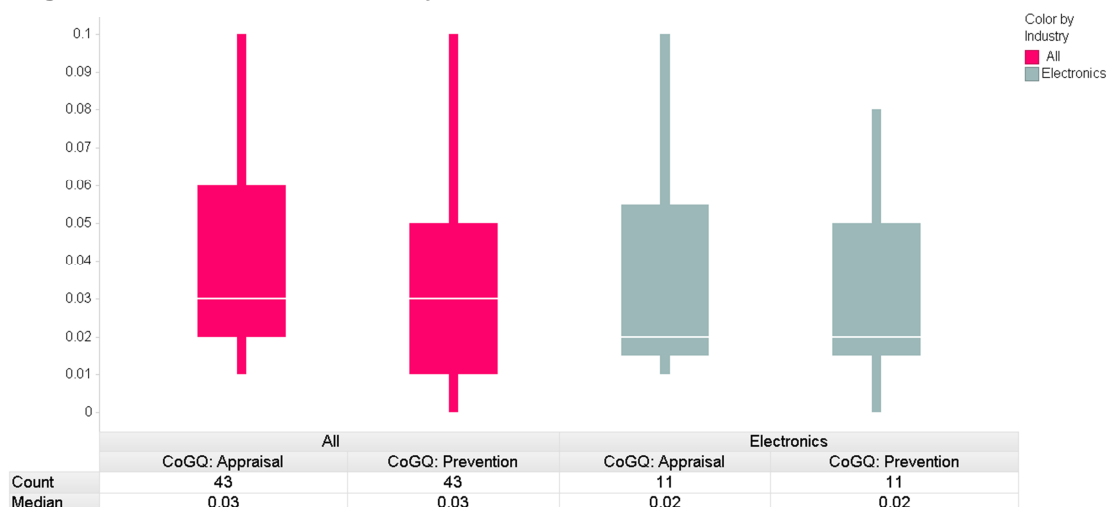
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#### *Cost of Good Quality Benchmark Data*

When asked about their 2012 performance in the cost of good quality, electronics industry respondents from the 2012-2013 Quality Management Survey recorded significantly lower numbers than those in other industries. This was consistent for both AC and PC. These electronics manufacturers were more effective with quality management investments. On the whole, these companies are getting more benefit from quality management software, being more likely to have automated and centralized quality management functionalities.

**Figure 5: Cost of Good Quality**

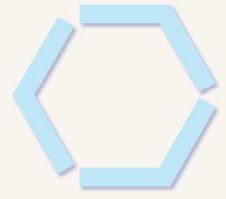


Leading electronics manufacturers are taking operational excellence to new heights by integrating an element of quality management-oriented objectives into the model.

## Operational Excellence and the Cost of Quality

Although the framework for an operational excellence model may vary by organization, it typically focuses on aligning key resources of people, process, and technology with operational and financial objectives. Leading electronics manufacturers are taking operational excellence to new heights by integrating an element of quality management-oriented objectives into the model. In addition to supporting overall quality initiatives by making them a top of mind issue, these quality objectives have direct effects on financial and operational objectives.

A critical component to any operational excellence model is a metrics program. These metrics help to make measurable improvements toward quality, financial, and operational objectives. There are many metrics available for the executive dashboard, none, though, are more encompassing and holistic than the cost of quality metric. However, to effectively measure the cost of quality and its core variables, it takes an organizational effort. People, processes, and technology must be poised for quality management success.



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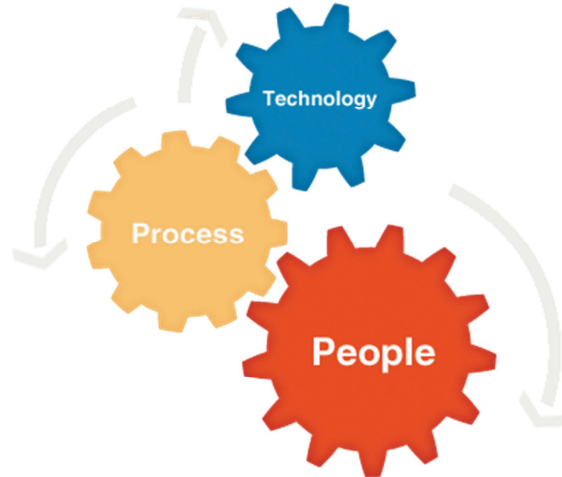
### Reducing the Cost of Quality in Electronics Manufacturing

The following section discusses the vital elements of people, processes, and technologies needed for a quality management-oriented operational excellence model. It is when these resources are in harmony with one another and optimized that the cost of quality can make a real impact on strategic objectives.

#### *People and Leadership Capabilities*

Executive buy-in is imperative for a quality management initiative to take hold. In the absence of a corporate quality leader, it may be necessary to appoint a Chief Quality Officer. This person as well as other senior management should help to drive a culture of quality throughout the entire organization and across the value chain. Developing or strengthening internal education programs, SOPs, and certifications such as Six Sigma can help with this. Steps organizations can take around people and leadership to support reducing the cost of quality are as follows:

- Make quality a top executive priority
- Include the cost of quality metric on the executive dashboard
- Develop cross-functional teams to communicate quality issues and manage quality across design, manufacturing, and suppliers
- Establish a formal risk management framework
- Incentivize improvements in the cost of quality metric

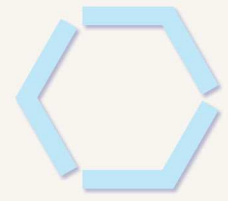


#### *Business Process Capabilities*

Since quality touches so many different areas of business, it is not unusual for there to be numerous manual processes and disparate management systems spread throughout the value chain. As there is a trend in the consolidation of intelligence across organizations today, market leading companies are moving toward the global use of automated, standardized, and centralized processes. Companies can align business processes in the following ways to support reductions in the cost of quality:

- Establish a formal NC/CAPA processes across the company

Executive buy-in is imperative for a quality management initiative to take hold. In the absence of a corporate quality leader, it may be necessary to appoint a Chief Quality Officer.



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- Develop closed-loop processes to connect quality across design, manufacturing, and suppliers
- Measure and monitor performance of suppliers with scorecards
- Use statistical analysis to monitor and analyze real-time supplier quality data
- Standardize escalation processes for supplier quality and non-compliance events (including recalls)
- Include suppliers in design for quality initiatives
- Ensure compliance processes are easily understood and documented
- Establish mediums for sharing compliance processes across functional areas
- Develop formal audit management processes

#### ***Technology Capabilities***

The emergence of Enterprise Quality Management Software (EQMS) and Cloud ERP solutions with strong quality management functionalities have put technology capabilities for quality management on a new trajectory. These solutions infuse a quality management perspective into every process across the value chain, acting as a platform for cross-functional communication and collaboration on issues. Quality Management Software provides executives with a holistic view of quality for making data-backed decisions. It helps to reduce the cost of quality in the following ways:

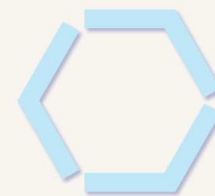
- Delivers real-time visibility of quality metrics in engineering, manufacturing, customer service, supplier performance
- Automatically collects supplier quality data through web-based portal
- Provides scorecard capabilities for measuring and monitoring supplier performance
- Establish traceability and containment capabilities

#### **Technology Roadmap for Optimizing the Cost of Quality**

Circling back to the discussion on cost of quality benchmark data, companies should pay close attention to the tradeoffs between CoGQ and CoPQ. It is often the case that spending or investing in CoGQ more than makes up for itself in reductions in the CoPQ. A great example of this would be an investment in Enterprise Quality Management Software (EQMS) or Cloud ERP.

Implementing an EQMS or Cloud ERP and integrating it with other functional areas of business, such as engineering, manufacturing, and the supply-chain, can facilitate the measurement of many cost of quality aspects. EQMS and Cloud ERP

The emergence of Enterprise Quality Management Software (EQMS) and Cloud ERP solutions with strong quality management functionalities have put technology capabilities for quality management on a new trajectory.



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are great tools for increasing visibility for executives and plant managers. Regardless of the CoGQ investment, the main focus should be on realizing positive ROIs by implementing capabilities or processes that will reduce the CoPQ.

**Figure 6: Enterprise Quality Management Software IT Architecture**

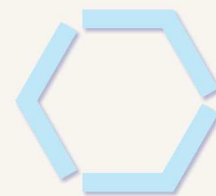


Regardless of the path taken, the key for a technology to deliver on both sides of the cost of quality equation is to be cost-effective on the system side, improve the effectiveness of quality personnel, and drive real performance benefits in suppliers, engineering, and manufacturing.

The tools available in these systems provide companies with multiple ways to measure and resolve quality issues. Regardless of the path taken, the key for a technology to deliver on both sides of the cost of quality equation is to be cost-effective on the system side, improve the effectiveness of quality personnel, and drive real performance benefits in suppliers, engineering, and manufacturing.

For the purpose of reducing the cost of quality, the following are key technology attributes for the portfolio of quality management functionalities:

- Functionality focused on Cost of Quality reductions, such as: NC/CAPA, FMEA, and SPC



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- Single integrated system for ERP, Engineering, Manufacturing, Supply Chain, and Quality
- Work-flow capabilities for flexibility in changing business processes
- Cloud-based with SaaS pricing model
- Web-based portal for supplier collaboration and visibility
- Integrated reporting and analytics for metrics
- Mobility for delivering data and access to critical applications
- Integrated traceability and containment solution for managing recalls

## Final Recommendations

It is important to be aware of the different industry challenges impacting electronics companies today; but for many the best way to address these challenges is still improving manufacturing efficiency. It is also important to remember that quality plays a major role in efficiency and that the Cost of Quality metric can be an important tool for benchmarking operations and ensuring the investments made in quality processes and systems are delivering the desired results.

Over time the best way to reduce the Cost of Quality is through a long term Operational Excellence initiative and ensuring it is supported by cost effective technology solutions that span operations and leverage important capabilities like cloud, collaboration, mobility, and business intelligence. It is also important to know where to start when bringing together Operational Excellence and the Cost of Quality. Approaches differ by company, but there has been a lot of success shown by starting with a few key capabilities like, executive focus on quality, closed loop quality processes, real time visibility into quality metrics in manufacturing and suppliers, and important EQMS functionality like NC/CAPA, FMEA, and SPC.

*The distribution of this report has been funded by:*



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