IBM Quality Early Warning System

*Drive better quality through advanced analytics*

**Our understanding of your goals**

In any supply chain or manufacturing operation, “time is money” when it comes to detecting quality problems. Even a small delay in detecting a quality problem can result in large costs from reworked or scrapped product, containment or recall of defective product, increased warranty expenses, loss of customer satisfaction, and potentially even legal liability. The scale and complexity of current manufacturing operations, internal and contracted, made it vital that supply chain quality problems are detected as early as possible – before suspect materials from suppliers ever enter the manufacturing plants or make it into production.

**The problem with typical SPC**

The limitations of traditional Statistical Process Control (SPC) used in quality problem detection are well recognized. Specifically, traditional SPC is largely reactive in nature, results in a large number of cumulative defects produced before alerting, and suffers from high rates of false alarms. Adding to this difficulty, recent industry efforts to apply modern analytical methods have also proved exceedingly difficult to implement on a scale useful for a complex, global supply chain. This is principally due to complex computational challenges and constraints in software implementation.

**Cumulative defects need to reach statistical significance**

- Slow to detect and requires a large number of cumulative defects to trigger a valid alarm

**Tightening control limits causes false positives**

- Simply reducing control limits can result in false positives, aka ‘statistical noise’

**More reactive**

- SPC is more reactive than predictive with limited abilities to detect trends before cumulative evidence

**No prioritization**

- Without ranking, corrective measures are likely to be taken on the lower priority issues
The Challenges

Quality and supply chain managers need advanced techniques to examine quality from tens of thousands of parts (incoming, manufactured, deployed) and to provide better, more proactive quality management.

Better analytical methods have been available but have proven exceedingly difficult to implement on a scale useful for a complex, global supply chain. This is principally due to complex computational challenges and constraints in software implementation.

The IBM solution

IBM’s new Early Warning System Approach

IBM’s Quality Early Warning System (QEWS) solves a widespread and important challenge which has persisted in business for decades: how to get earlier detection of emerging supply chain quality problems, and actionable information about these problems in order to save money and improve customer satisfaction.

IBM’s QEWS approach provides an enterprise wide solution to capture the opportunity of earlier, predictive detection of developing quality problems at a low rate of false alarms, and thus provides a competitive advantage in cost and quality for an industry wide problem.

It is a software system which uses proprietary IBM technology to detect & prioritize quality problems earlier with fewer false alarms, coupled with push alert functionality for the organization and suppliers to proactively detect & manage quality issues at any stage of product lifecycle.

Solution overview

QEWS represents the first enterprise-level system which combines the Cumulative Sum sequential analysis technique (CUSUM) with intelligent alert prioritization and effective dashboarding. CUSUM is recognized as an optimal statistical method for change detection. However, implementation obstacles (such as the complexity of computations, development of algorithms for detection and alarm thresholds, and development of alarm prioritization criteria) have prevented it from being used to its full potential.

In developing QEWS, IBM made a number of advances to enable effective deployment of a CUSUM-based methodology. These advances include:

- **Automated, “on the fly” detection threshold generation**: an algorithm that enables rapid evaluation of massive amounts of data to identify the most appropriate thresholds;
- **Actionable alarms**: alarms which are automated, prioritized, readily analyzed, and easily pushed to system users inside and outside of the organization; and
- **An effective dashboard**: an easily navigable interface to enable quick navigation of vast amounts of quality data.
CUSUM's high computational demands were met by developing innovative and efficient software. The user-friendly interface was built using advanced web technologies. IBM developed a centralized, web-based multi-dimensional database model with data drill-down capabilities to enable rapid identification of suspect material or parts.

QEWS has proved highly effective in protecting supply chain and manufacturing operations. Subtle changes in failure rates (in components, subassemblies, firmware, or completed product) indicative of potential emerging quality problems might now be detected weeks, and even months, earlier than was possible without QEWS.

The definitive nature of QEWS alerts eliminates the need for subjective judgment of SPC control charts and other traditional tools, providing the entire engineering staff, management and suppliers with consistent and accurate direction. QEWS’ automatic monitoring of the supply chain, and a clear dashboard showing real quality issues presented in priority order, empower the organization to work proactively with suppliers, rather than reactively.
QEWS implementation in IBM

Business Challenge

In the mid-2000’s, IBM’s Integrated Supply Chain (ISC) experienced ballooning operational expenses, rework costs, and warranty exposure in some equipment brands as the supply chain evolved, grew in complexity and in partner numbers.

Quality and supply chain managers has the need for much better techniques to examine quality date from tens of thousands of parts and to provide better, more proactive quality management. IBM’s complex supply chain required disciplined issue and quality manage processes

The solution using analytics

ISC paired with IBM Research to develop a comprehensive quality management program, using advanced analytics. The solution is Quality Early Warning System (QEWS).

The solution pair early warning with issue prioritization to provide actionable recommendations, and examines data to identify trends much faster than traditional SPC approaches.

Its uses a configurable dashboard view of quality trends by various variables, eg brand, product number, facility, supplier, part number, etc..

QEWS is deployed globally at ISC, including 20+ manufacturing sites, 7 hardware brands, 200+ suppliers, 450 machine-type models, 3200 unique feature codes, 100K+ product / test combinations.

The Benefits

QEWS has proved highly effective in protecting IBM’s supply chain and manufacturing operations. Subtle changes in failure rates (in components, subassemblies, firmware, or completed product) indicative of potential emerging quality problems are now typically detected weeks, and even months earlier than what was previously possible. The graphs below illustrate an example of early detection using QEWS analytics (top chart) vs traditional SPC (bottom chart); in this case 8 weeks earlier. This allows for quicker problem identification, faster problem resolution, and lower total costs.
QEWS Chart (same x-axis as SPC)
- QEWS alerts when the cumulative evidence line crosses above a horizontal threshold line (in black)

SPC Chart (same x-axis as QEWS)
- SPC indicates around the mean (solid red line) for much of this reporting period
- SPC alerts when the evidence line crosses the upper control limit, shown on this graph on the far right

Earlier Detection
- QEWS alerts 8 weeks before SPC

- Cost savings – Has saved over $38M in quality related costs since deployment in 2008
  o Warranty costs down
  o Quicker, more effective problem resolution
  o Less rework
- Proactive quality management mode – allows ISC to operate in proactive (not reactive) mode identifying and resolving quality issues before problems manifest themselves in product and customer satisfaction issues
  o Shows trends not typically visible in traditional SPC methods
  o Maintains low rate of false positives
- Improved quality processes – improves efficiency and effectiveness of quality processes
  o Common methodology deployed across all HW brands
  o Directs automated alerts to quality managers
  o Prioritizes need for follow-up of emerging issues
Improving end-to-end quality management using QEWS

QEWS has enabled a monumental step in quality management for the technology industry at large. This is accomplished through proactive alerts and a more efficient and effective quality process; made possible by advanced analytics on an enterprise-wide scale. This system is also applicable for all industries that rely on procurement and manufacturing as well as those who consume their products. IBM’s Quality Early Warning System standardizes the quality management process across the entire the supply chain of globally integrated enterprise and enables a unified and consistent approach through automation of the advanced analytics and alert prioritizations. This has enabled personnel across the entire supply chain to spend less time on problem detection, and more time on problem resolution. The resultant effort is increased productivity, greater client value, and lower overall operational costs.

Why IBM?

IBM continues to invest our substantial financial resources and intellectual capital to support new analytics and technology innovation for a range of engineering and procurement business processes. Our industry-leading analytics technologies and solutions, combined with proprietary process maturity, deep understanding of supply chain management, internal and industry benchmarks, enable us to commit to business outcomes. We work to listen, understand and leverage the full breadth of IBM’s investment to meet the unique requirements of your business—all to empower you to achieve continuously higher performance.

For more information

To learn more about IBM’s Engineering Services, please contact your IBM representative or Mr Lim Shu Chen, Engineering Services leader for GMU at limsc@sg.ibm.com.

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