Expanding the Quality Paradigm

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ABSTRACT

The concepts of Statistical Process Control are applied to measures of external quality. We describe how doing so will provide early identification of discontinuous changes in markets and customer preferences thereby allowing an early and cost effective response.

I. INTRODUCTION

The apparent dichotomy between the methods of statistical process control (SPC) and the process improvement methods of Total Quality Management (TQM) are often a source of confusion to students. Indeed, many basic texts in Operations Management (e.g., 10) fail to relate the two in any meaningful fashion. Quality Control (QC) methods are typically presented in terms of the statistical procedures associated with creating p charts, x bar charts, and so forth. In the minds of many, "QC procedures" are directed at answering the "in control/out of control" question. In this context, quality is defined as conformance to specifications ("cts").

The usefulness of these procedures is best demonstrated by placing them in an application context where attention can be given to the question of what comes next after determining a process is "in" or "out of" control. Deming (3) provides the foundation for this process in his characterization of common cause variation ("ccv") and special cause variation ("scv"). Acknowledging that all processes exhibit variation, the quality concern is that of determining whether variation observed arises from the natural variation inherent in the process or whether some special (or untoward) phenomena is producing variation beyond that expected when the process is operating as designed.

When "scv" is found, the process is deemed to be "out of control" and attention is given to identifying the nature of the "special cause" and removing it so the process will resume functioning as designed. An emphasis on process is the natural result of addressing the determinants of "special cause variation" and procedures developed to this end have been applied broadly with significant success. Presently, the terms "Quality Management" and "Total Quality" are taken to refer primarily to process analysis and process improvement. Generally, in TQM little or no attention given to variation in the process analyzed.

In the following, we present a framework that integrates these different perspectives and forms a basis for quality assessment and improvement that will maximize the effectiveness of efforts devoted to quality. This new paradigm will permit quality assessments to be accomplished in a more systemic fashion than before and quality problems to be addressed more efficiently.

II. PERSPECTIVES ON QUALITY

A third perspective on quality must be added to the two described above. This is the notion of the locus of quality. Both SPC and TQM have internal operations as their focus. This is appropriate since actions to improve quality must principally be directed at the organization and how it functions. The external view of quality stands in contrast to "cts" and is generally characterized as value and fitness for use or "v+ffu." This customer- or user-"centric" view of quality goes well beyond the cts perspective of internal quality.

External quality is based on product characteristics. Product design is a principal source of external quality, manifested in process design and process execution. External quality arises from product design and is delivered by process execution. External quality is created by aspects of process execution beyond the obvious 'product must work.' Process execution must produce output in a timely fashion (lead times short and due dates met), customer service needs must be satisfied and revisions to customer orders must be accommodated routinely. The organization's ability to respond well to variability in the demands placed on it is a major contributor to external quality performance.

These other product attributes including price, durability, availability, delivery timing, support, and so forth contribute significantly to external quality. Customer demands along these dimensions can exhibit significant variation and this variation should be measured and assessed in much the same way that SPC methods track cts. Most organizations pay little explicit attention to this variation but do employ a variety of mechanisms for coping with it. These mechanisms are typically developed in an *ad hoc* fashion and often are not the subject of objective analysis or attention.

III. AN ENLARGED VIEW OF QC

It should now be clear that external quality should be controlled by a process whose structure parallels that for controlling internal quality. Variability in measures of external quality can be categorized as having a "common cause," (i.e., observed variations are within historical boundaries) or as having a "special cause." The origins of special cause variation may be a discontinuous change in the environment necessitating a special response. The methods of SPC, it would seem, are particularly well suited to assessing observed variation in external measures and providing an indication of the existence of special causes.

The table below presents a summary of quality types, how variation is manifested in each, the categories of variation observed, appropriate diagnostic procedures, and the general nature of remedies that should be pursued. The first column describes the locus of the variation (internal or external). The second column describes how the variation manifests itself (i.e., what it is that

varies). The third column indicates whether the variation is due to "common" or "special" causes.

IV. A BROADENED PERSPECTIVE ON QULAITY CONTROL AND PROCESS IMPROVEMENT

What to do about variability is the "control" side of quality control. Clearly, variability arising from special causes should be treated differently than that arising from common causes. Even though the existence of common cause variation does not motivate immediate remedial action, action may nevertheless be undertaken to reduce this variation or its effects. Column four of the table indicates the basic technique appropriate for diagnosing variation and column five suggests broad categories of responses to it.

It is interesting to note that this classification scheme brings many elements of external quality under the control umbrella. To be sure, some aspects of external quality are not controllable by the producing organization. Many are, however, and by identifying these and determining whether observed variation is due to common or special causes, we provide the basis for efficient and effective control action.

In the remaining discussion, we devote our attention to the implications of this structure for controlling external quality. A brief review of the elements of the table devoted to internal quality will reveal that it breaks no new ground, providing a summary of well known (and broadly applied) control tactics.

Organizations do control operations so that common variation in customer need is accommodated. These are the controllable aspects of external quality. Maintaining inventories of finished products is an obvious illustration. Forecasting demand levels (buying information) is another, equally obvious, mechanism for anticipating variation in demand for products. Less obvious is the implementation of new technologies that enable a swifter and more instrumental response to varying customer needs.

It has been argued (5) that operations employ a mix of tactics to respond to variation in customer needs, thus controlling their response to common cause variation in measures of external quality. By making this tactical mix explicit, an objective basis for incremental improvement is established.

Special cause variation in external quality deserves immediate and purposeful attention. Its existence may well indicate environmental changes that could produce significant and far reaching effects on the organization. Special cause variation is difficult to identify, particularly when it first occurs. Generally speaking, when the existence of special causes that negatively influence external quality become apparent, response and remedial actions are both difficult and costly. Early detection of special cause variation is, perhaps, more important in control of external quality than in internal quality.

Adequate responses to special cause variation in external quality are generally 'heroic' if they are to be effective. Early knowledge of their existence is crucial so that action may be taken before

the situation becomes irretrievable. Early detection depends on continued tracking of variation in those measures effecting external quality and immediate investigation of any changes that goes beyond established control limits.

V. EXPANDING THE QUALITY HORIZON

By expanding the mechanics of SPC to tracking measures of external quality, we provide a basis for rational improvements in operations. These arise from identifying and assessing the nature of common cause variation in customer needs. Defining common cause variation also specifies when special cause variation occurs. This variation may have far reaching and significant effects. When it occurs, early and instrumental action is called for to preserve competitive position and the viability of the business.

Locus/Determinants	**Manifestation**	**"Problem" (Causation)**	**Diagnosis (Procedures)**	**Response/Remedy**
Locus: Internal "cts" conformance to specifications Determinants of Internal Quality: • Process Design • Process Execution	Variation in measured characteristic of output within established control limits	"ccv" Common Cause Variation	SPC Statistical Process Control	None unless quality standards are to be improved, then: • Risk Assessment • Risk Management • Continuous improvement (Kaizen) • Six Sigma
	Variation in measured characteristic of output outside established control limits. Includes specifications of products produced and process performance measures (flow times, materials support, etc.)	"scv" Special cause variation	• Pareto Analysis • Flow Chart • Check Sheet • Histogram • Scatter Diagram • Cause & Effect Diagram (Fishbone Diagram)	Remedies • ISO 9000 • Maintenance • Process re-design (BPR, Benchmarking) • Quality Function Deployment • Poka yoke • Jidoka • Theory Of Constraints • Training • Improved technology • Outsourcing
Locus: External "v+ffu" Value and Fitness for Use Determinants of External Quality • Product Design • Process Execution • Alternative, substitute products available	Variation (change) in: • Product characteristics demanded • Payment performance • Timing of demands • Quantity demanded • Product specifications • Price elasticity of demand • Service requirements • Customer support req'd.	"ccv" Common Cause Variation	Period to period tracking along "manifestation" dimensions.	Revise tactical mix: • Buffer • Buy Info • Share • Standardize • Diversify • Increased responsiveness • Influence environment
	Occurrence of • Change to External Economic Environment • Technological advances • New entrant • Paradigm shift (often discontinuous)	"scv" Special cause variation	Environmental scanning	• Product re-design • Revise business model • Reposition product • Seek new markets

REFERENCES

No attempt is made to provide a comprehensive list of resources for this subject. The following list includes representative, and some seminal, entries to support the development of the concepts presented.

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