Successfully Using SPC in Service Applications

Methods and Case Studies

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Objectives

Value of SPC/SQM in Service Settings
• Control Charts, Other Tools
• Cost of Quality → When to “Inspect”?

Examples:
• HMO Enrollment Process, Labs
• Customer Satisfaction, Others

References for Further Info

Value of SPC/SQM in Service Settings

Background and Motivation

Essence of Dr. Deming’s Message

“SPC in Service Industries: Case Studies” ~ Page 2 ~ James Benneyan & Associates

Understand Process Performance

“The reality is that (quality control procedures) increase work... and cost... Many studies have shown that a Total Quality Management system adds at least 25% to overall laboratory costs.”

The Cost of TQM?

One Opinion...?

“Simply stated, quality improvement refers to organized, rational, scientifically valid programs that analyze what people are doing - in industry, medicine, or any other area - and then devise ways in which the job can be done even better.”

SPC tools can help with this understanding

References for Further Info


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tel/fax: 617-522-0616; e-mail: benneyan@coe.neu.edu
Dr. W. Edwards Deming
A Different Way of Thinking About Quality and Costs

Improve Quality \(\Rightarrow\) Reduce Total Costs

The philosophy of “Quality Management”, understood and instituted effectively, reduces long-term total costs:

- Understand, improve, and control process quality
- Statistical process control
- Economic models to minimize total costs

Member Enrollment Case Study

Member Enrollment Process

Process Improvement Team

High Data Entry Error Rate, Long T-A-T

Regular Meetings
- Review data, Study process
- Identify root causes of errors

Missing fields, Numeric Fields, Unfamiliarity
Training, Form simplification, others

“Diagnostic Journey” . . .

Sources of Errors?

Pareto Chart

Due to High Volumes?
Scatterplot & Correlation Analysis

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Control Chart Mini-Tutorial:
Customer Satisfaction and Service Complaints

Annual Satisfaction Survey
Standard “Time-Static” Comparison
Comparison by Service Line

Given the Following, What Do You Conclude...?
Customer Satisfaction Index

Given the Following, What Do You Conclude...?
Service Dissatisfaction (Product F)
Past Few Months

Yet There is Natural Variability Here
Also Unnatural Special Cause Variability

Example of “In Control” Process
No Irregular Events - Only “Natural” Variability

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A Different Kind of Variability
Poor Service Quality - Deteriorating Over Time

Back to the Member Enrollment Process...

Improving Enrollment Process
(Turn-Around-Time Also Control Charted)

Suppose Improving Trend Continues?
(Special-Purpose Trend Control Chart)

Should They Be Inspecting At All?
Dr. Deming's "14 Points" (Point 3)

4 General Inspection Approaches
Objective: Minimize Total Quality Costs

"Successully Using Statistical Process Control (SPC) in Service Applications"
Deming’s k1/k2 Cost Model

Simple Method to Minimize Costs

Cost / Input Estimates:
- Fraction Data Entry Errors (p) - 0.005
- Number Entered per year - 150,000
- Cost to Inspect an Item (k1) - $0.52
- Cost of Undetected Error (k2) = ??? ($0.58 \leftrightarrow $35)

Annual Cost for Each Inspection Policy
- See references for formulas


Cost of Poor Process Quality

0% vs. 100% vs. Partial Inspection

Simple k1/k2 Criterion

Minimize Total Poor Quality Cost

If

\[ \frac{k_1}{k_2} \leq p \]

⇒ 100% Inspect

\[ \frac{k_1}{k_2} > p \]

⇒ 0% Inspect

Partial Sampling Never Minimizes Total Costs!! (Counter-Intuitive)


Other Benefits

“We have eliminated unnecessary work, streamlined our key processes, and replaced frustrating work with more meaningful work. The new process also significantly reduces turn-around-time... with less resources.”

- Manager of Enrollment Process

- Increased staff & customer satisfaction
- Other applications, transfer process . . .

Deming was Right!

Higher Quality ⇒ Lower Costs

Annual Savings of Process Improvements

- Enrollment Process Improvements ($42K)
- Final Inspection Eliminated ($78)

Other SPC and Inspection Service Applications

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Other Identified HMO Applications

Possible Savings $600,000/year

- Medical Records
- Prescription Accuracy
- Internal Audit, Cash Handling
- Accounts Receivable
- Outside Utilization Authorization
- Clinical laboratories . . .

Other k₁/k₂ Applications

Average 5% net operating costs common

- Accounts Receivable Dept ($5M - $1M/year)
- Bank Payroll Dept ($4.75 per transaction)
- Insurance Eligibility Review
- Integrated TV circuits ($24/set - 15% of mfg cost)
- Auto Engine Testing ($47/motor - $185,000/day)
- Biomedical Device lawsuit (Loss of life)

Where do You Partial, 0%, or 100% “Inspect”?

Some Other Service SPC Uses

Many Others . . .

- Budget Variances, Sales, Utilization
- Timeliness of Subways, Trains, Planes
- Census Data Accuracy, Process Times
- U.S. Postal Service
- Banking, Finance, Insurance
- Public Utilities, Government, Accident Rates
- Customer Satisfaction/Complaints
- Service Calls & Response Times . . .

Information Systems Support

Help Desk Service Calls

Number of Service Calls u Control Chart

Histogram of Number of Weeks Late (Early)

Time to Return Service Calls

Where Would You Start Investigating?

Response Time \( \bar{X} \) (‘X-bar’) Control Chart

On-Time Delivery

Deviation from Customer Requested Date

Histogram of Number of Weeks Late (Early)
Is It Getting Any Better?
A Special Type of Control Chart: In-Process Orders

Fraction of Due Orders Shipped

Laboratory Applications

Lab Pap Smear Figures

- Approximately 50 Million Annually (USA)
- 200,000 Cervical Cancer Deaths/year
- Estimated 1.5% of Pathologists Involved in Litigation for False Negative Readings
- Cure Rate in Early Stages Near 100%
- Advanced Cervical Cancer Much Less Successfully Treated

Laboratory Quality Concerns

- Several Recent False Negative Settlements:
  - $3.5 Million
  - $6.3 Million
  - Recent Criminal Charges
- Diane Sawyer (Newport Hospital) - 1994
- 1988: Congressional Hearings and Federal Clinical Laboratory Improvements Act (CLIA)

CLIA’88 10% QC Requirement

How Well Does This Process Perform?

Some Criticisms of CLIA’88

“... 10% rescreening ... is a waste of everyone’s time and effort.”
W.M. Hindman, M.D.

“Using rescreening of 10% of the negative gynecologic smears, it would take 11 years to distinguish between acceptable and unacceptable performance of a cytotechnologist.”
G.M. Lundberg, M.D.
Lab “Inspection” Costs?
Multiple \( n \) Readings, \( \% \) Re-read

Expected Cost per \( n \) Processed Smears

\[
EC = k_n \left\{ \frac{1 - p}{1 - \alpha_c} + \frac{1 - (1 - p)}{\beta_c} \right\} k_1 \left\{ \frac{1 - (1 - \alpha_c)}{1 - (1 - \alpha_c)} \right\} + k_2 \left( \frac{1 - \alpha_c}{1 - p} \right) \left( 1 - \beta_c \right)
\]

where \( p = \) Incidence rate of truly positive patients

\[
p' = p \alpha_c + (1 - p) \left( 1 - \alpha_c \right)
\]

Optimal Number of Readings?
One Example

Partial Rescreening Never Optimal!
Similar to the \( k_1/k_2 \) Criterion

\[
\begin{align*}
k_1 &+ k_2 \left( \frac{1 - \beta_c}{1 - \alpha_c} \right) \left( \frac{p + 1 - p}{p'} \right) < 1 \Rightarrow 100\% \text{ Rescreen} \\
\left( \frac{k_2}{p} \right) \left( \frac{1 - \alpha_c}{1 - \beta_c} \right) \left( \frac{1 - p}{p'} \right) &> 1 \Rightarrow 0\% \text{ Rescreen}
\end{align*}
\]

Sound Familiar . . . ?
(Widely applicable in many other settings . . .)

Summary of Pap Smear Analysis
Studied via SPC & Quality Cost Methods

- CLIA’88 Increases Total Costs
- Negligible Reduction in False Negatives
- Never Optimal Policy
- Automated Screening often Much Worse!

SPC is a Correct Quality Assurance Method

Role of SPC in Lab Quality
Mammography (Spring et al)

“A continuing longitudinal study, reviewing data over several years, may detect unexpected sources of false-negative errors...”

“Monitoring may identify areas of patient care that fall short of evolving national standards...”

“Trends in clinical performance that indicate less than optimal care can be identified...”

Sounds Like SPC!

Management Recommendations
What To Do Instead? (Any Process)

1. **Optimize** Current Process via Cost Models
2. **Control** Current Quality via SPC
3. **Improve** Process (Sensitivity & Specificity) via CQI, DOE, Human Factors, etc.

What does doing it right mean?
Lab process quality has significantly changed. Poor Quality is Preventable!

Reasons for Poor X-rays?

Pareto Chart

HIV Quality Control Chart

Downward Trend in Calibration

How Concerned Should Patients Be?

Endemic Philosophical Errors

- Non-Mfg processes can not be interpreted via SPC and natural variability?..?
- QA should focus on outcomes (inspection), rather than on processes (prevention)?...
- Over-reliance on high level metrics
- SPC ° Software and automation
“Successfully Using Statistical Process Control (SPC) in Service Applications”

“SPC Not Applicable Here” Syndrome

Voluntary Disenrollment (Customer Dissatisfaction)

Month

“Our processes shouldn’t be in control” !?

Common Statistical Errors

- Using an X chart without an S or S² chart
- Overuse / misuse of “individuals” chart
- “Short-cut” control limit formulas
  - Invalid....!!
  - Not using 3 standard deviation limits
  - Not using at least 25 to 35 subgroups
- Frequent use of incorrect chart . . .

Accounts Receivable Controls

Freight Administration h Control Chart

Some References

Abridged Bibliography


For More Information . . .

For additional references, tutorial articles, case studies, specifics on any of the illustrated applications, and/or assistance with statistical quality control, please contact:

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