Quality Cost Worksheets

We've included a set of cost worksheets in this chapter to help you get rough estimates on the amount of money you can save by improving your quality design and control. There are no guarantees in life, and I can't promise that these worksheets can take into account all the factors involved in Six Sigma Quality Management. However, I hope these worksheets help you get started. Even a rough estimate of the waste generated by poor quality is illuminating. I'm sure if you plug in a few numbers, you'll be motivated to make improvements.

If you're truly going to calculate the cost savings from improved QC, you'll need to fill out a set of worksheets for your current practices, then work through the quality-planning process to select a more appropriate QC procedure, and fill out the worksheets based on the new QC procedure. Then you can see the difference between your current QC costs and your potential QC costs.

The savings you can realize can be determined by

- (Worksheet I) **Internal Failure Cost Savings = Current - New**
- (Worksheet II) **External Failure Cost Savings = Current - New**

Working through the quality-planning process and selecting a new QC procedure can be accomplished in a variety of ways: (1) By using a manual method like Normalized OPSpecs charts (2) By using online quality-planning tools at http://www.westgard.com/qptools.html or (3) By using software support such as QC Validator® 2.0 or EZ Rules™.

If you don’t work through the quality-planning process, then you will only be able to determine your current costs. You won't be able to compare those costs to your potential future costs, so you won't know the size of your potential savings, etc. Identifying the cost of a wasteful QC procedure is important, but ultimately it’s only useful if you replace it with a more efficient QC procedure. So remember to take the next step: use the quality-planning process to find a more efficient QC procedure that meets the quality required by the test.
Quality Cost Worksheet I Directions

This worksheet doesn’t require any hard work. Just pick a test and start filling out the worksheet. You should already know the answers to these simple questions: How many tests are in a run? How many runs are there in a year of operation? What control rule are you using? If you don’t know these details off the top of your head, they should be available somewhere in your laboratory.

The only piece of information that you might not already have is presented in the table below: the false rejection rate of the control rule that you’re using for the test. You probably know what control rule you are using and how many controls you are running. For example, if you are using the 2s control rule and running 2 controls, you will look at the intersection of the first row (1_{2s}) and the second column (2) and find the number 9%. This means that 9% of the runs performed on this test will be falsely rejected (i.e. rejected even though there is nothing wrong with them).

This cost can’t be reduced, unless you use a better control rule!

False Rejection Rates of Common Control Rules

<table>
<thead>
<tr>
<th>Control Rule</th>
<th># Controls per Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1_{2s}</td>
<td>5%</td>
</tr>
<tr>
<td>1_{2.5s}</td>
<td>1%</td>
</tr>
<tr>
<td>1_{3s}</td>
<td>0%</td>
</tr>
<tr>
<td>1_{3.5s}</td>
<td>0%</td>
</tr>
<tr>
<td>1_{3s}/2_{2s}/R_{4s}</td>
<td>-</td>
</tr>
<tr>
<td>1_{3s}/2_{2s}/R_{4s}/4_{1s}</td>
<td>-</td>
</tr>
<tr>
<td>1_{3s}/2of3_{2s}/R_{4s}</td>
<td>-</td>
</tr>
<tr>
<td>1_{3s}/2of3_{2s}/R_{4s}/3_{1s}</td>
<td>-</td>
</tr>
</tbody>
</table>
## Quality Cost Worksheet, Part I: Waste & Rework

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>System</th>
</tr>
</thead>
</table>

1. Runs/Day  
2. Days/Year  
3. Control Rule in use  
3a. False Rejection (Pfr) - use table  
4. Number of Controls per Run  
5. Estimated Cost per Control  
6. Number of tests in each test group  
7. Cost per test  

**False Rejection test cost:** If you repeat the *entire* test group. Multiply $1 \times 2 \times 3a \times 6 \times 7$.

**False Rejection control cost:** If you only repeat controls. Multiply $1 \times 2 \times 3a \times 4 \times 5$.

8. Average hourly rate of employees who perform the rework (“repeat run”)  

9. Average amount of time consumed when one run of this test must be redone.

**Rework labor cost:** Multiply $1 \times 2 \times 3a \times 8 \times 9$.

**TOTAL COST OF WASTE & REWORK:** Add Control cost + Test cost + Rework labor cost

This is the cost of rework if the test performs *perfectly*. If any real problems occur, the cost of rework is more!
Quality Cost Worksheet, Part I: Waste & Rework

<table>
<thead>
<tr>
<th>Test</th>
<th>Cholesterol Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>ABC Inc.</td>
</tr>
<tr>
<td>System</td>
<td>DEF Analyzer</td>
</tr>
</tbody>
</table>

1. Runs/Day 2
2. Days/Year 365
3. Control Rule in use 1:2s
3a. False Rejection (Pfr) - use table 0.09
4. Number of Controls per Run 2
5. Estimated Cost per Control $0.50
6. Number of tests in each test group 20
7. Cost per test $0.50

**False Rejection test cost:** If you repeat the *entire* test group
Multiply 1 x 2 x 3a x 6 x 7. **$657.00**

**False Rejection control cost:** If you only repeat controls
Multiply 1 x 2 x 3a x 4 x 5. **$65.70**

8. Average hourly rate of employees who perform the rework ("repeat run") **$20**

9. Average amount of time consumed when one run of this test must be redone. **1.0 hours**

**Rework labor cost:** Multiply 1 x 2 x 3a x 8 x 9. **$1,314**

**TOTAL COST OF WASTE & REWORK:** Add Control cost + Test cost + Rework labor cost **$2,036.70**

This is the cost of rework if the test performs *perfectly.*
If any real problems occur, the cost of rework is more!
Quality Cost Worksheet, Part I: Waste & Rework

<table>
<thead>
<tr>
<th>Test</th>
<th>Cholesterol Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>ABC Inc.</td>
</tr>
<tr>
<td>System</td>
<td>DEF Analyzer</td>
</tr>
</tbody>
</table>

1. Runs/Day 2
2. Days/Year 365
3. Control Rule in use 1:3s/2:2s/R:4s
4. Number of Controls per Run 2
5. Estimated Cost per Control $0.50
6. Number of tests in each test group 20
7. Cost per test $0.50

**False Rejection test cost:** If you repeat the *entire* test group
Multiply $1 \times 2 \times 3a \times 6 \times 7.$ $\boxed{73.00}$

**False Rejection control cost:** If you only repeat controls
Multiply $1 \times 2 \times 3a \times 4 \times 5.$ $\boxed{7.30}$

8. Average hourly rate of employees who perform the rework (“repeat run”) $\boxed{20}$

9. Average amount of time consumed when one run of this test must be redone. 1.0 hours

**Rework labor cost:** Multiply $1 \times 2 \times 3a \times 8 \times 9.$ $\boxed{146.00}$

**TOTAL COST OF WASTE & REWORK:**
Add Control cost + Test cost + Rework labor cost $\boxed{226.30}$

Note for this example, switching from the 12s rule to a “Westgard Rule” provides immediate reduction in waste.
Quality Cost Worksheet II Directions

*Estimating Error Frequency*

Estimating the frequency of errors should be straightforward if you have previous records about the test and method. The number of true out-of-control flags (remember, discount false alarms) as a percentage of the total number of runs will give you the frequency of errors.

If you don’t know for sure what the frequency of errors is for a good test, use this rule of thumb: An excellent method has only about a 1% occurrence of errors. A normal method has somewhere between 1 and 5% occurrence of errors. A poor method has more than 5% occurrence of errors. Start with an estimate of the error frequency and see what the numbers say.

**Calculating Error Detection, \( P_{ed} \)**

You need to do some work in order to figure this out. In order to accurately find the error detection you’re achieving with your current QC procedure, you need to go through the quality-planning process. You will need to use an OPSpecs chart and possibly a critical-error graph. As stated elsewhere, these graphic tools are available in manuals, as online tools, and as software.

If you know at least the analytical quality requirement, the imprecision, and inaccuracy, you can use an OPSpecs chart to select a QC procedure. The OPSpecs charts are commonly available for 90%, 50% and 25% error detection. Obviously, it’s best to find a control rule on an OPSpecs chart for 90% error detection. And if you find a control rule above your operating point on that chart, you’ve succeeded and can enter 0.90 in the worksheet.

If you use a critical-error graph, you’ll still need the same details as the OPSpecs chart — but you’ll get a specific number for error detection, not just 0.90 or 0.50 or 0.25. Then you can enter that number in the worksheet.

If you really must, start with an estimate of 0.90 in the worksheet. This will give you the “best case” scenario for your external failure costs. But even the best case may surprise you...
Quality Cost Worksheet II: External Failure Costs

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>System</th>
</tr>
</thead>
</table>

It’s unlikely you can estimate all these costs -- but you can’t pretend they don’t exist!

1. Runs/year
2. Patients/run
3. Error Frequency (how often is there a true problem?)*
4. Probability of Error Detection**
5. What is the estimated cost (time, labor) to repeat the test?
6. What is the estimated cost of extra patient care?

Key Questions:

7. Is this an appropriate level of error detection?
   If no, answer the questions below.
7. YES
   7. NO

8. Can you accept reporting erroneous results?
   If yes, estimate this cost: ________________
8. YES
   8. NO

9. Can you accept a Proficiency Testing failure?
   If yes, estimate this cost: ________________
9. YES
   9. NO

10. Can you accept misdiagnosis/mistreatment of patients?
    If yes, estimate this cost: ________________
10. YES
    10. NO

TOTAL OF EXTERNAL FAILURE COSTS:
Lab cost of external failure: Multiply 1•2•3•(1.0-4)•5 ________________
Extra patient care cost: Multiply 1•2•3•(1.0-4)•6 ________________
Total of above: ________________
Other potential costs: Cost of PT Failure, Cost of litigation for mistreatment, fines, penalties

Note: if you can’t fill out boxes 1 - 6, you may be answering yes to 8 - 10!!
Please also note: If you are willing to release erroneous results from your lab, please resign.
Quality Cost Worksheet II: External Failure Costs

<table>
<thead>
<tr>
<th>Test</th>
<th>Cholesterol - Current method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>ABC method</td>
</tr>
<tr>
<td>System</td>
<td>DEF Analyzer</td>
</tr>
</tbody>
</table>

1. Runs/year 730
2. Patients/run 20
3. Error Frequency (how often is there a true problem?)* 0.01
4. Probability of Error Detection** 0.20
5. What is the estimated cost (time, labor) to repeat the test? $100
6. What is the estimated cost of extra patient care? $1000

Key Questions:

7. Is this an appropriate level of error detection? If no, answer the questions below.

8. Can you accept reporting erroneous results? If yes, estimate this cost: ______________________

9. Can you accept a Proficiency Testing failure? If yes, estimate this cost: ______________________

10. Can you accept misdiagnosis/mistreatment of patients? If yes, estimate this cost: ______________________

TOTAL OF EXTERNAL FAILURE COSTS:

Lab cost of external failure: Multiply 1•2•3•(1.0- 4)•5 $11,680.00
Extra patient care cost: Multiply 1•2•3•(1.0-4)•6 $116,800.00
Total of above: $128,480.00

Other potential costs: Cost of PT Failure, Cost of litigation for mistreatment, fines, penalties

Note: If you can’t fill out boxes 1 - 6, you may be answering yes to 8 - 10!!
Please also note: If you are willing to release erroneous results from your lab, please resign.
Quality Cost Worksheet II: External Failure Costs

<table>
<thead>
<tr>
<th>Test</th>
<th>Cholesterol example - future method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>ABC method</td>
</tr>
<tr>
<td>System</td>
<td>DEF Analyzer</td>
</tr>
</tbody>
</table>

It's unlikely you can estimate all these costs -- but you can't pretend they don't exist!

1. Runs/year  730
2. Patients/run  20
3. Error Frequency (how often is there a true problem?)*  0.01
4. Probability of Error Detection**  0.90
5. What is the estimated cost (time, labor) to repeat the test?  $100
6. What is the estimated cost of extra patient care?  $1000

Key Questions:

7. Is this an appropriate level of error detection?
   If no, answer the questions below.

8. Can you accept reporting erroneous results?
   If yes, estimate this cost: ________________

9. Can you accept a Proficiency Testing failure?
   If yes, estimate this cost: ________________

10. Can you accept misdiagnosis/mistreatment of patients?
    If yes, estimate this cost: ________________

TOTAL OF EXTERNAL FAILURE COSTS:

Lab cost of external failure: Multiply 1•2•3•(1.0-4)•5  $1,460.00
Extra patient care cost : Multiply 1•2•3•(1.0-4)•6  $14,600.00
Total of above:  $16,060.00

Note: In this example, achieving 90% error detection dramatically reduces costs.
However, even 90% error detection has its cost. Achieving true 6-sigma performance
would reduce this cost to pennies!
Where to start?

Six Sigma Quality Management is a big job in a laboratory that performs hundreds of different tests. Where should you start? Begin with tests where you can make the biggest impact, such as automated chemistry and hematology analyzers that perform a significant portion of the laboratory workload. Place a high priority on any tests where the current QC practice uses 2 SD control limits.

In the end, it's up to you!

I hope you’re convinced that doing QC right is important and that Six Sigma Quality Management and the quality-planning process is the way to know what QC is needed. You have the tools. You know the process. You’ve seen how it’s done. Now it’s your turn!