

## TOOL SPOTLIGHT

# Quality Function Deployment Matrix

### What Is It?

The quality function deployment (QFD) matrix is a tool used in the Measure phase of a DMADV (Define, Measure, Analyze, Design, Verify) project to summarize the research data gathered as part of the project. It is useful for understanding customer needs and prioritizing the critical design requirements to meet those needs. It also allows you to understand key competitive measures and the relative performance of those measures among your competitors. Most of the work in developing a QFD matrix involves compiling information. The information is then organized into various "rooms" that make up the matrix, which is why the QFD matrix is also called the house of quality.

### Why Use It?

To coordinate a vast amount of information and select the key measures that you will use in the rest of the design process

### How Do I Do It?

To build a QFD matrix, as illustrated in Figure 4 on page 20:

1. List the detailed voice of the customer (VOC) needs in the rows of the matrix and the measures for the critical-to-quality factors (CTQs) in the matrix columns.
2. Fill in the cells of the matrix by asking, "If we design the process, product or service to perform to the target specified for the measure, to what extent would we have met the need?"
  - Use values of 1 for low correlation, 3 for medium correlation and 9 for high correlation. It is not necessary to fill all of the cells with a 1, 3 or 9; typically about one-third of the cells are filled.
  - An empty row indicates that a measure does not exist for the need; if the need is important, then you must define a measure for the need.
  - An empty column may indicate that the measure is not needed because it does not correspond to any need; it may also signal that a need was missed in the VOC. (Remember that customers often fail to mention must-be needs.)
3. Calculate the importance of each CTQ.  
Use matrix multiplication, which is described under Room 4 on page 20.

**Tip:** If your VOC research indicates that you have customer segments with very different needs, create a QFD matrix for each segment. (Note: You may need to create different products or services for these segments.)

The importance rating calculated in Step 3 above is the output of the QFD exercise. Your objective in using the QFD matrix is to find the smallest number of CTQs that meet the largest number of needs.

Figure 1:  
The Rooms of the QFD Matrix

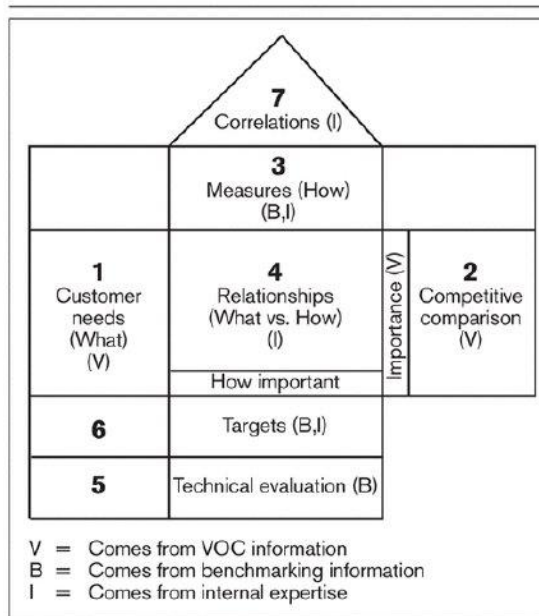


Figure 2:  
Connections and Relationships Among the Rooms

Room	Contents	Where does this information come from?
1. Customer needs	Prioritized customer needs	The voice of the customer
2. Competitive comparison	Customer rating of key competitors' performance	The voice of the customer
3. Measures	Customer requirement measures (CTQs)	Benchmarking and the design team
4. Relationships	Relationship of CTQs to customer needs	Internal expertise and the design team
5. Technical evaluation	Actual performance of competitors on measures	Benchmarking
6. Targets	Performance required to meet CTQs/needs	Benchmarking and internal expertise
7. Correlations	Correlation between the measures	Internal expertise

### The Rooms of the QFD Matrix

The QFD Matrix is divided into seven rooms (Figure 1). Just like the rooms in a house, there are connections and relationships among the rooms (Figure 2).

#### Room 1

Room 1 lists the key detailed customer needs identified by VOC research. These needs have been defined and prioritized by customers and are listed in the matrix in the customers' language.

**Tip:** Be sure to include in the matrix all must-be needs and key more-is-better needs, as determined by performing a Kano analysis. Also include delighters if possible.

#### Room 2

Room 2 graphically shows how customers perceive your organization's performance and at least two competitors' performance with regard to meeting the customer needs listed in Room 1. Information gathered from VOC research is used to establish how customers perceive the performance of your organization compared to market leaders.

**Tip:** In your comparison, use direct competitors who are market leaders or "excellence organizations." Select symbols to designate your organization's performance and the performance of the competitors you are comparing yourself with. Connect the symbols with lines to provide a better visual representation of customers' perceptions of the performance comparisons. Use a scale of 1 to 4 (with 4 representing how the "perfect" service or product performs) to rate performance.

You can easily collect the information for this room as you gather your VOC data. Use several sources of information to identify customers' perceptions of your competitors, including:

- Customer satisfaction surveys that collect information on customer ratings of both your organization and key competitors.
- Industry databases.
- Your own VOC research.

#### Room 3

Room 3 represents the voice of your design team and lists the measures developed at the end of the VOC analysis. Ideas for measures can come from:

- The design team's work translating customer needs into CTQs (which include measures).
- Benchmarking information on how similar characteristics are measured.
- Measures currently in use for similar designs.

**Note:** Don't worry about having too many measures; there are often more measures than customer needs. (Each need could be addressed by multiple measures.) The QFD matrix will help you eliminate unnecessary

measures so that only the most important measures will be carried over into the next phase of the design process.

Note that some measures are intentionally vague. For example, the measure "percent information about completed order status accessible by customer" will be different depending on the design you choose and on the technology you use. (The particular technology is irrelevant; any solution should be able to meet the target specified for this measure.)

**Tip:** Make sure the measures are measurable during design. For example, the measure "number of complaints" won't help you during design because it can only be measured after the product or service is in the market.

Indicate a preferred direction for the measures with arrows on the matrix (e.g., higher is better). To determine direction, ask:

- If we increase this measurement, will that help to achieve the customer need?
- If we reduce this measurement, will that help to achieve the customer need?
- If we hit the measurement target, will that help to achieve the customer need?

Allow adjustments of the measure's value as you make design decisions. Do not make the measure solution-dependent to prevent biasing yourself toward one outcome.

#### Room 4

Room 4 summarizes your thinking about the relationship between potential measures and the customers' needs. To determine these relationships, compare each measure (from Room 3) with each need (from Room 1) and ask, "If the design meets the target set for this measure, to what extent will we meet the customer need?" Use your experience, knowledge and expertise to help you formulate the answers.

When recording the relationships in Room 4, document the assumptions that led to your decisions about the relationships. You can return to this documentation later when you test parts of the design.

**Tip:** Use symbols or numbers (9, 3 or 1) in Room 4 to show the strength of the relationship between the measures and the needs (Figure 3). Use a double circle (or a 9) to show a strong relationship (a direct cause and effect). Use a single circle (or a 3) to indicate a moderate

Figure 3:

Symbols to Show the Strength of Relationships in Room 4

				
	Strong	Moderate	Weak	None
Weight	9	3	1	0

# TOOL SPOTLIGHT

relationship. Use a triangle (or a 1) to signal a weak relationship. Indicate that no relationship exists by leaving blank the space where the need and measure intersect.

Calculate the importance of each measure by multiplying the relationship weight (9, 3 or 1) by the importance that customers assigned to the need from the column marked "Importance" in the matrix. (Remember that customers provided these importance ratings when they prioritized or ranked their needs.) Then add the scores within the column and record the scores in the "How important" row at the bottom of the matrix. Use these scores in your discussions to check your thinking and to help identify the key measures that drive overall customer satisfaction. These key measures become the most important criteria against which to evaluate the design.

**Caution:** Do not let the results of the calculations by themselves make the decision on prioritizing the measures. You could have a measure with a relatively low total number because it correlates with only one need. However, if that need is a must-be need, the measure is important to keep.

### Room 5

Room 5 summarizes the technical benchmarking data that compares your company to your competitors with respect to performance on key measures/design requirements. Again, use symbols to represent your organization and your competitors, just as you did in Room 2. Connect the symbols using lines and rate the comparison on a scale of 1 to 5 (with 5 representing "better" in this room).

Benchmarking your processes, products or services, along with the processes, products or services of others, against key design measures identified will help you to define the current level of performance and to answer the questions:

- Have you defined the right measures to predict customer satisfaction?
- Does the process, product or service have a perception problem (i.e., a difference in Room 2), as opposed to a technical problem (a difference in Room 5)?

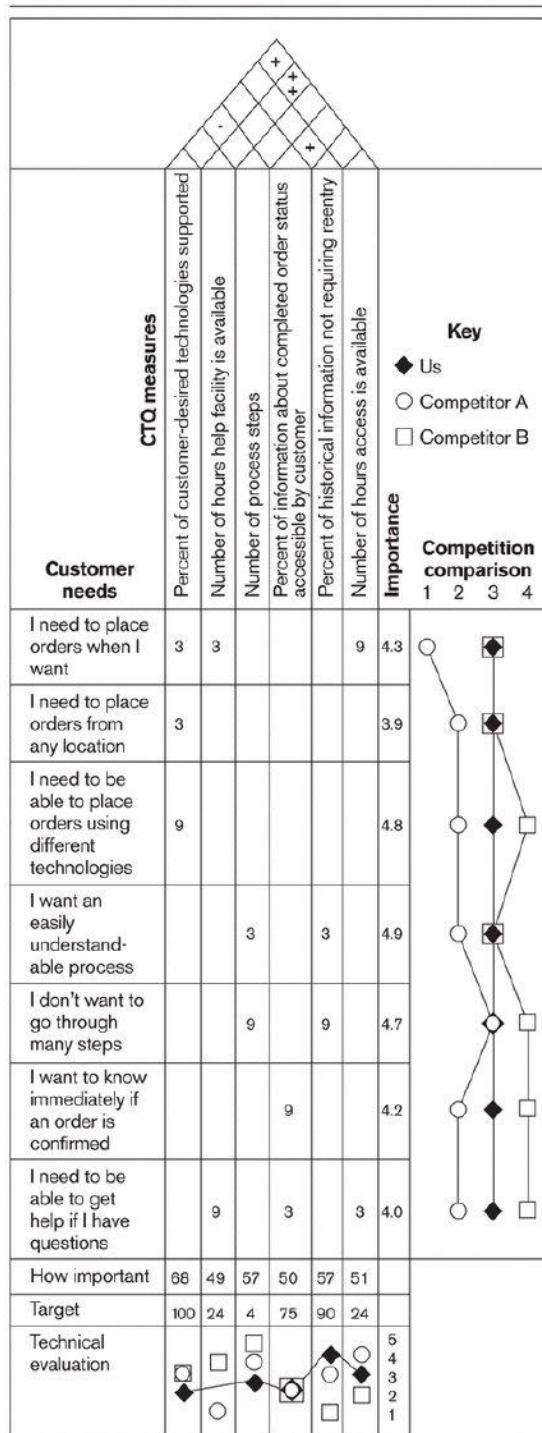
### Room 6

Room 6 summarizes the targets that you have already established for the measures/CTQs. Summarize the targets by examining the data gathered throughout the process and determine what you are going to do with respect to this process, product or service.

### Room 7

Room 7 (the "roof") summarizes the relationships between the measures. Determine if a positive or negative relationship between measures exists by asking, "If we design to meet CTQ 1, to what extent do we satisfy or what will the effect be on CTQ 2?" If CTQ 2 will also move toward its target, then there is a positive effect. If CTQ 2 is not affected, then the effect is neutral. If CTQ 2 moves away from its target, then the effect is negative.

Figure 4:  
Sample QFD Matrix



Use symbols (such as + and -) to represent the relationships and then evaluate the outcome. Positive relationships indicate synergy and negative relationships may indicate conflicts.

**Tip:** The design task becomes easier if you have a lot of positives in the roof of the matrix. A positive relationship indicates that if one aspect of the design is improved, other aspects will be improved as well. If you have a lot of negatives in the roof of the matrix, then you have design contentions; improving one aspect of the design may lead to problems in other aspects. If you have too many design contentions, you may have to develop more creative designs that transcend the contentions, or carefully evaluate trade-off decisions that you may have to make.

### Analyzing QFD

Use QFD analysis in the Measure phase to help you see at once all of the information that you have gathered and to guide a systematic discussion of the measures as you prioritize the design requirements of the CTQs. If the design has only a few measures, you may not need to use the QFD matrix because you may not need to prioritize the measures. However, if you have a lot of measures, you need to select a few important ones to use in the next design step as you assess potential concepts.

You can also use QFD analysis to help recognize opportunities to leverage design efforts and identify any trade-offs.

Ultimately, the QFD matrix should serve as a validation of your business instincts. The QFD matrix scores are simply the inputs to discussions. Your team's expertise and knowledge of the customer needs will guide your decisions.

If the exercise produces results that do not match your intuition, ask these questions before accepting the results:

- *Are all the needs at the same level?* If needs are at various levels of detail, there may be multiple statements describing the lower-level needs and one statement describing the higher-level need. This will cause the CTQs describing the lower-level needs to appear to be more important than those for the higher-level need.

- *Are there multiple measurements when one might suffice?* Multiple measures correlated with the same need may result in a narrow set of design specifications concentrating on just one aspect of the design.
- *Are there any empty rows?* Empty rows indicate that the measure set is not complete.
- *Are there any empty columns?* Empty columns indicate redundant measurements or a must-be need that is not represented in the matrix.
- *Is the matrix in Room 4 diagonal?* A diagonal pattern indicates that you may have defined the measures too narrowly.
- *Is there a mismatch between the customer evaluation data in Room 2 and the technical benchmarks in Room 5?* A discrepancy may indicate a mismatch between perception and reality.

**Tip:** In some cases, the information from one QFD matrix may be sufficient to proceed with the preliminary design. In other instances, you can use QFD analysis to further deploy the customer needs into design specifications via additional QFD matrices. This is particularly true for products that are assembled from parts.

To begin a second QFD matrix, place the measures from Room 3 of the first matrix as the "whats" in Room 1 of the second matrix. Then use your judgment to determine "how" to accomplish the measures. Identify the functions needed in the design and put them in Room 3 of the second QFD matrix. Then use the same process you used previously to complete the matrix.

As shown in Figure 5, you can develop several matrices to achieve a very detailed understanding of the variables to control to ensure that you satisfy the customer needs. ♦

*Edited article, reprinted with permission, from The Design for Six Sigma Memory Jogger™© 2004 by GOAL/QPC.*

Figure 5:  
Additional QFD Matrices to Deploy Further Needs

