# Quality Function Deployment in Emergency Planning and Management

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## ABSTRACT

Quality Function Deployment (QFD) is an engineering tool for organizing and ranking information into matrix form in order to understand the attributes or actions that are needed to achieve a common goal, and to align cross-functional teams strategically to quickly and efficiently meet that common goal. Although this tool has been used primarily in the manufacturing world for product or process planning, it can easily and effectively be applied at various levels within the emergency planning/ response environment as an aid to prioritize critical resources. Applications will be discussed at the personal or user level, local emergency response level, state and federal levels. By utilizing QFD, these entities will be better able to address emergency situations. QFD can also be a cornerstone to continuously improve readiness to handle the crucial time just prior to, and just after, the emergency occurs.

## INTRODUCTION

Quality Function Deployment (QFD) is a dynamic planning and analysis tool that can be used in numerous ways to assist in organizational planning and decision making. QFD organizes and ranks information into matrix form in order to understand the attributes or actions that are needed to achieve a common goal, and as such provides a good planning tool for emergency management planners and engineers. Brainstorming, a proven method of effectively gathering information from a large number of people can be more effective when done in conjunction with QFD.

QFD originated in Japan as an outgrowth of work done by Dr. W. Edwards Deming, an American statistician, at the end of World War II. The Japanese, with their industrial base destroyed, needed to rebuild in an expedient and efficient manner. QFD was one of the tools that was developed in order to take into account the expertise of various management roles throughout a company, and use that expertise to prioritize improvement efforts. In the mid-1980's, as a number of American industries found themselves now overcome by Japanese competitors, they went to Japan and discovered that QFD was one of the essential tools that helped in Japan's amazing economic recovery. Since QFD came to be used in the US, companies such as Ford Motor Co., IBM, Hewlett-Packard, Allied-Signal Aerospace, have used QFD to strategically plan for improvement projects, product mix decisions, service issues, etc.

This paper will illustrate how QFD can also be used to help in emergency planning and engineering. Examples at the end of the paper show applications for use at the individual user level, at the local response level and at state and federal levels. The examples will be illustrating hurricane preparedness in the state of Florida, but are general enough to show how QFD can be used in other emergency planning in other locations and with other scenarios.

## HOW QFD IS DONE

QFD is also know by the term "House of Quality", due to the distinctive shape of the matrix, see Figure 1. The matrix is created sequentially, with the discussion of critical issues at each stage done in a structured, efficient manner. Often more than one matrix is created for a topic. The first matrix is a high level overview, succeeding matrices are a flow-down of more detail, possibly focusing only on one sub-topic each.

### Creating the Grid

The right side of the matrix consists of a list of "what's". Although in the original uses of QFD this is a list of customers' expectations, for emergency planning purposes, this can be a list of what is needed to be done in pre-disaster or post-disaster planning. A variation on this part of the matrix is to create a primary, secondary

and even tertiary lists that get further and further into specific detail.

Across the top of the matrix is the list of "how's". This list is created after the "what's" and should be done separately, but of course can be cross-referenced against the first list. In the case of an emergency management application, the methods used by the agency to carry out the pre-disaster / post-disaster activities may be a part of this "how's" list.

The next stage of the matrix is the point where the relationships between the what's and the how's are determined. This grid is filled in by looking at each "what" and determining the strength of it's relationship to the corresponding "how" using ranked values. A very strong relationship is given a value of 6. A strong relationship is given a value of 3, and a weak relationship, a value of 1. In the case of no relationship between a what and a how, the square is left blank, and has a corresponding value of 0.

A column is placed just next to the list of "what's" (the tertiary or final list) that ranks the importance of carrying out each item. These ratings are given a rank of:

5 = mandatory
4 = necessary
3 = desirable
2 = minor
1 = minimal

The correlation matrix, located above the "how's", is known as the roof of the house. This part of the QFD chart uses symbols to define the relationship matrix, and determines the strength of the technical interrelationship between each of the "how's". A strong positive relationship is designated by a solid circle, a positive relationship is designated by an open circle, a negative relationship is an "x", and a strong negative relationship is a "double x". No numerical ranking is used in this section but is instead used to facilitate discussion, and will possibly influence the final outcome.

Prioritizing the Information

At the bottom of each "how" column a tally is made. This tally is the sum of each "what" importance value multiplied by the values in the relationship matrix.

The final part of the basic QFD chart consists of an evaluation of "how well" each of the "what's" is currently being executed. For disaster planning purposes this can be a ranking of how well that particular activity was carried out during the last few same-type disasters. See the following example for clarification.

## USING QFD FOR EMERGENCY PLANNING

Each agency who is involved in the management of emergencies may have its own QFD application and houses of quality. The following list provides first level QFD matrices for local, state and federal emergency management efforts. In each case we list the potential "what's" for the agency followed by the "how's". Naturally, if desired, in the next level of QFD matrices we may list the "how's" of the first level as "what's" of the second level, in a cascading manner. We must then develop the necessary "how's" corresponding to these new "what's" at level two. This hierarchical decomposition of "how's" and "what's" may be continued to the level of detail needed by the specific agency.

QFD for Local Response

The QFD analysis can serve good purpose in helping local agencies provide quick and adequate response to disasters. A partial example consisting of a list of "what's" and "how's" for the local emergency management team at level 1 follows.

**What's**

- Provide timely and accurate storm information
- Provide adequate safety
- Provide rapid mitigation efforts
- provide adequate shelters
- Provide adequate guidance
- Provide basic needs
- Provide outside communication

**How's**

- Accurate tracking of storm
- Accurate estimate of landfall/ consequences
- Accurate estimate of resource needs prior to landfall
- Accurate estimate of resource needs during the hurricane landfall

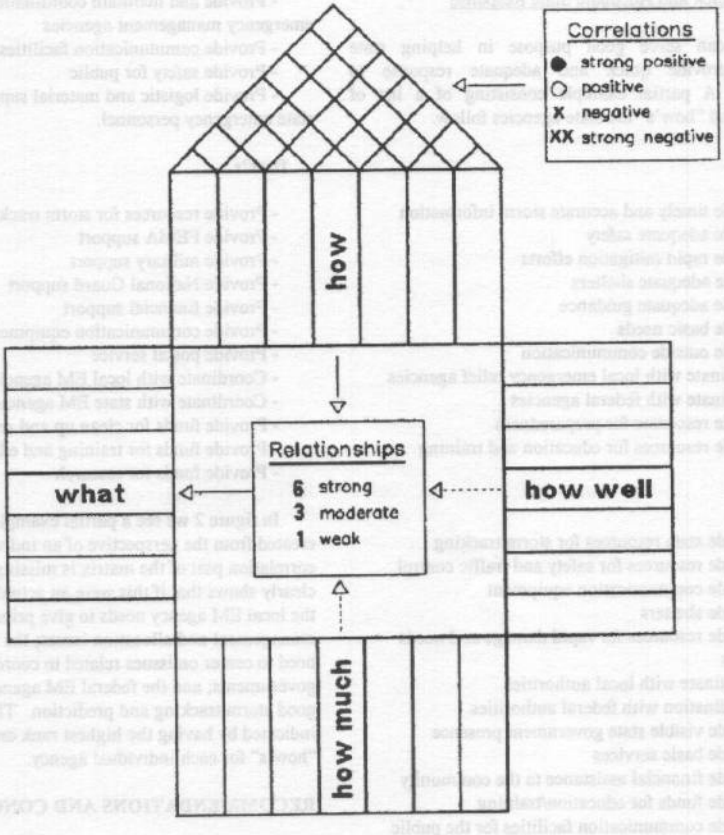


Figure 1. A Sample House of Quality

- Accurate estimate of resources needed after the hurricane
- Population/crowd control before, during and after the hurricane
- Resource management and allocation
- Traffic control for better evacuation
- Shelter management for optimal shelter utilization
- Provision of basic services for sheltered people
- provision of postal and telecommunication facilities for the residents

QFD for Quick and Adequate State Response

QFD can serve good purpose in helping state agencies provide quick and adequate response to disasters. A partial example consisting of a list of "what's" and "how's" the state agencies follow.

**What's**

- Provide timely and accurate storm information
- Provide adequate safety
- Provide rapid mitigation efforts
- provide adequate shelters
- Provide adequate guidance
- Provide basic needs
- Provide outside communication
- Coordinate with local emergency relief agencies
- Coordinate with federal agencies
- Provide resources for preparedness
- Provide resources for education and training

**How's**

- Provide state resources for storm tracking
- Provide resources for safety and traffic control
- Provide communication equipment
- Provide shelters
- Provide resources for rapid damage and needs assessments
- Coordinate with local authorities
- Coordination with federal authorities
- Provide visible state government presence
- Provide basic services
- Provide financial assistance to the community
- Provide funds for education/training
- Provide communication facilities for the public

QFD for Quick and Adequate Federal Response

QFD can serve good purpose in helping federal agencies provide quick and adequate response to disasters. A partial example consisting of a list of "what's" for federal government follows.

**What's**

- Provide quick federal presence
-Provide resources for mitigation efforts
- Provide resources for preparedness
- Provide resources for training and education
- Provide and maintain coordination with local emergency management agencies
- Provide and maintain coordination with state emergency management agencies
- Provide communication facilities for the public
- Provide safety for public
- Provide logistic and material support to local and state emergency personnel.

**How's**

- Provide resources for storm tracking
- Provide FEMA support
- Provide military support
- Provide National Guard support
- Provide financial support
- Provide communication equipment
- Provide postal service
- Coordinate with local EM agencies
- Coordinate with state EM agencies
- Provide funds for clean up and rebuilding
- Provide funds for training and education
- Provide funds for research

In figure 2 we see a partial example of a QFD chart created from the perspective of an individual. The "roof" correlation part of the matrix is missing, but the chart clearly shows that if this were an actual working chart, the local EM agency needs to give priority to its resource management and allocation issues; the state EM efforts need to center on issues related to coordination with local governments; and the federal EM agencies need to assure good storm tracking and prediction. These priorities are indicated by having the highest rank on the list of "how's" for each individual agency.

## RECOMMENDATIONS AND CONCLUSIONS

In the previous section we introduced a sample level one house of quality for local EM agencies, state agencies and federal agencies. Naturally, we can continue this hierarchical decomposition by making the "how's" at

| | | Priority | Quick Lcl. Resp. | Coord. w/ St. & Fed. Gov. | Accur. & Timely Storm Inf. | Resource Estimation | Crowd Control | Resource Mgt. & Alloc'n | Evac. Traffic Control | Shelter Mgt. | Provide Communication | Provide Basic Services | Quick St. Resp. | Coord. with Federal Govt. | Coord. with Local Gov't | Presence of Law Enf. | Presence of St. Auth. | Disaster Declaration | Rescs. for Lcl. EM Team | Financial Aid to People | Provide Training | Quick Fed. Resp. | Pres. of Fed. Auth. | Disaster Declaration | Provide Material to State | Provide Relief Funds | Provide Research Funds | Storm Tracking and Pred. | Provide Law Enforcement | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 519 | 343 | 464 | 356 | 563 | 485 | 469 | 499 | 467 | | 516 | 627 | 366 | 298 | 184 | 581 | 126 | 529 | | 343 | 143 | 425 | 135 | 282 | 631 | 430 | |
| | Effective Relief Support | 4 | | 6 | | 6 | | 6 | 3 | 3 | 6 | 6 | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 3 | 6 | 6 | | | 6 | 117 |
| | Law Enforcem't/ Security | 4 | | 6 | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | | 6 | 6 | 6 | | | 6 | | 6 | | 6 | | 1 | | | 6 | 6 | 97 |
| | Urban Search & Rescue | 5 | | 6 | | 6 | 1 | 6 | 6 | | 6 | 6 | | 6 | 6 | 3 | | | 6 | | | | 6 | | | | | 3 | 6 | 85 |
| | Mass Care & Transport'n | 5 | | 6 | | 6 | 3 | 6 | 6 | 6 | 6 | 6 | | 6 | 6 | | | | 6 | | | | 6 | | 6 | | 6 | 6 | 6 | 111 |
| | Quick Return to Normalcy | 3 | | 6 | | 1 | 6 | 6 | 6 | 6 | 6 | 6 | | 6 | 6 | | 6 | 6 | 6 | | | | 6 | 6 | 6 | | | 6 | 6 | 121 |
| | Fire Fighting | 4 | | 1 | | 6 | 1 | 6 | 6 | | 6 | 6 | | 6 | 6 | | | | 6 | | | | 6 | | 6 | | | 6 | 6 | 89 |
| | Food | 5 | | 3 | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | | 6 | 6 | | | | 6 | | 1 | | 3 | | 6 | | | 6 | 6 | 91 |
| | Water | 5 | | 6 | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | | 6 | 6 | | | | 6 | | 1 | | 3 | | 6 | | | 6 | 6 | 94 |
| | Materiel for Rebuilding | 4 | | 3 | | 6 | 6 | 6 | 6 | | 3 | 6 | | 6 | 6 | | 1 | 3 | 6 | | 1 | | 3 | | 6 | 6 | | 6 | 6 | 104 |
| | Financial Support | 3 | | 6 | | 3 | 6 | 6 | | | 6 | 6 | | 6 | 6 | | | 6 | 6 | | | 6 | | 6 | | | | 6 | | 81 |
| | Public Works & Equipm't | 4 | | 6 | | 6 | 1 | 6 | 1 | | 1 | 6 | | 3 | 6 | 1 | 6 | 6 | 6 | | 6 | | 3 | | 6 | | 6 | 6 | | 82 |
| | Effective Shelter Mgt | 3 | | 1 | 1 | 3 | 6 | 6 | 3 | 6 | 6 | 6 | | 3 | 6 | 6 | 3 | | 6 | | 6 | | 3 | | 3 | | | 6 | 6 | 86 |
| | Communicat'n & Command | 4 | | 6 | 1 | 1 | 1 | 3 | 3 | 6 | 6 | 6 | | 6 | 6 | 3 | 3 | 1 | 6 | | 6 | | 3 | 3 | 6 | | 6 | 1 | 6 | 89 |
| | Effective State Help | 4 | | 6 | 6 | 6 | 1 | 6 | 6 | 3 | 6 | 6 | | 3 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | | 3 | 6 | 3 | | 6 | 6 | 6 | 121 |
| | Effective Federal Help | 4 | | 6 | 6 | 6 | 1 | 6 | | 1 | 6 | 6 | | 6 | 3 | 6 | 6 | 3 | 6 | | | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 116 |
| | E.M Personnel Assignm't | 4 | | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | | 6 | 1 | 1 | 1 | 1 | 6 | | 6 | | 3 | | 1 | | | 6 | 6 | 85 |
| | Effective Rumor Control | 3 | | 3 | 6 | 1 | 6 | 1 | 3 | 6 | 6 | 6 | | 3 | 6 | 6 | 6 | 1 | 1 | | 6 | | 3 | 3 | 3 | | | 6 | 6 | 91 |
| | Effective Resource Alloc'n | 3 | | 3 | 6 | 6 | 1 | 3 | 3 | 6 | 1 | 6 | | 6 | 6 | 6 | 1 | 1 | 6 | | 6 | | 3 | 1 | 3 | 6 | 1 | 6 | 6 | 93 |
| | Contin. Update of Situat'n | 5 | | 6 | 6 | | 6 | 3 | 3 | 6 | 6 | 3 | | 6 | 6 | | | 1 | 1 | | 6 | | 1 | 1 | | | | 6 | 3 | 70 |
| | Effective Damage Estimate | 3 | | 6 | 6 | 1 | | 1 | | | 6 | | | 6 | 6 | | 6 | 6 | 6 | | 6 | | 3 | 6 | | | 3 | 6 | 3 | 77 |
| | Good Evacuation Time Est. | 4 | | 6 | 3 | | 3 | 6 | 6 | 6 | 3 | | | 6 | 6 | 1 | 1 | | 6 | | 6 | | 3 | | | | 3 | 6 | | 74 |
| | Good Evacuation Popul Est. | 4 | | 6 | 6 | 6 | 3 | 6 | 1 | 6 | 3 | | | 6 | 6 | 1 | 1 | | 6 | | 6 | | | 3 | | | 3 | 6 | | 75 |
| | Good Damage Estimation | 4 | | 6 | 6 | 6 | | 3 | | | | | | 6 | 6 | 1 | 3 | | 6 | | 6 | | | 3 | | | 3 | 6 | | 61 |
| | Good Storm Tracking | 5 | | 6 | 6 | 1 | 3 | 6 | 3 | 3 | | 1 | | 6 | 6 | | 3 | | 6 | | 6 | | 3 | | 6 | | 6 | 6 | | 77 |
| | Resource Allocation | 4 | | 6 | 6 | 6 | 1 | 6 | 3 | 3 | | 3 | | | 3 | 1 | 3 | | 6 | | 6 | | | | 6 | | 3 | 6 | 1 | 69 |
| | Effective Traffic Control | 3 | | 3 | 6 | 1 | 6 | 6 | 6 | 6 | | | 3 | | 3 | 1 | 3 | | 6 | | 6 | | | 1 | | | 3 | 6 | 3 | 69 |
| | Effective Shelter Assignm't | 3 | | 1 | 6 | 6 | 6 | 6 | 6 | 6 | | | | | 3 | | 3 | | 6 | | 6 | | | 1 | | | 3 | 6 | 3 | 68 |
| | Broadcast Information | 5 | | 1 | 6 | 1 | | 1 | 6 | 6 | 6 | | | | 3 | | 3 | | 3 | | 1 | | 1 | | | | | 6 | | 44 |
| | Published Preparedness Inf. | 3 | | 1 | | | | | 6 | 6 | 3 | | | 1 | 3 | 1 | 3 | 1 | | | | | | | | | | | | 25 |
| | Published Shelter Inf. | 3 | | 1 | | | | | 6 | 6 | 3 | | | 1 | 3 | 1 | 3 | | | | | | | | | | | | | 24 |

Figure 2. A House of Quality from Individual's Perspective

level one the "what's" at level two, the "how's" at level two the "what's" at level three, etc.

With the cumulative importance rating of each "how" the appropriate agency may prioritize the action plans and focus on the ones that needs improvements.

Furthermore, comparing how the previous hurricane efforts fared on each "what" item, we can assess the "how's" we need to focus on to improve the ratings on particular "what's".

QFD provides us a systematic and integrative method to evaluate our past performance and map out our future direction in improving the quality of our emergency response in dealing with hurricane emergencies.

QFD can become an invaluable tool in planning for both pre-disaster, during and post-disaster activities. Much of what is learned in handling one disaster can dissipate quickly after debriefing meetings occur. QFD can be used as a method to assure that that does not occur.

Disaster planning agencies using QFD will find their weaknesses and will be able to use QFD as justification for bolstering weaknesses.

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