

BS ISO 16355-5:2017



BSI Standards Publication

Applications of statistical and related methods to new technology and product development process

Part 5: Solution strategy



National foreword

This British Standard is the UK implementation of ISO 16355-5:2017.

The UK participation in its preparation was entrusted to Technical Committee MS/6, Methodologies for business process improvement using statistical methods.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2017.
Published by BSI Standards Limited 2017

ISBN 978 0 580 80503 5

ICS 03.120.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 February 2017.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

**Applications of statistical and related
methods to new technology and
product development process —**

**Part 5:
Solution strategy**

*Application des méthodes statistiques et des méthodes liées aux
nouvelles technologies et de développement de produit —*

Partie 5: Stratégie de solution





COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Management summary	1
4.1 Basic concepts of QFD	1
4.2 Evolving classical QFD into modern QFD	2
4.2.1 General	2
4.2.2 Classical QFD	2
4.2.3 Comprehensive QFD	2
4.2.4 Matrix of matrices	3
4.2.5 Modern Blitz QFD®	3
4.2.6 German QFD Institute model	3
5 Integration of QFD and product development methods	4
5.1 QFD support for product development methods	4
5.2 Flow of solution development with QFD	4
5.2.1 Organization of the QFD flow	4
5.2.2 Flow charts of strategy and translation of VOC into engineering solutions and cost planning	4
6 Types of QFD projects	4
7 QFD team membership	4
7.1 QFD uses cross-functional teams	4
7.2 Core team membership	4
7.3 Subject matter experts	4
7.4 QFD team leadership	5
8 Seven management and planning tools	5
9 Translation of one information set into another	5
9.1 General	5
9.2 Maximum value table	6
9.2.1 General	6
9.2.2 Effect-to-cause diagram	6
9.2.3 Steps to make a maximum value table	7
9.2.4 Modern QFD	10
9.3 L-matrices	10
9.3.1 General	10
9.3.2 Entering information into L-matrices	11
9.3.3 Determining effect-to-cause relationships in a QFD L-matrix	11
9.3.4 Linking matrices	11
9.3.5 Comprehensive QFD	12
9.3.6 House of quality	12
9.3.7 Knowledge management	17
10 Transfer of prioritization and quantification from one information set into another	17
10.1 General	17
10.2 Transfer of prioritization	18
10.2.1 Quantify strength of relationships in the matrix	18
10.2.2 Weight the rows	19
10.2.3 Calculate the column weights	20
10.2.4 Distribution methods	21
10.3 Transfer of quantification	24

10.3.1	General.....	24
10.3.2	Quantify row information.....	24
10.3.3	Use relationship weights to connect row quantification to column quantification.....	25
10.3.4	Quantify column information.....	25
10.4	Transferring deployment sets by dimensions and levels.....	37
10.4.1	Deployment sets.....	37
10.4.2	Quality deployment.....	39
10.4.3	Technology deployment.....	44
10.4.4	Cost deployment.....	64
10.4.5	Reliability deployment.....	67
10.4.6	Lifestyle and emotional quality deployment.....	79
10.5	Transferring deployment sets by levels.....	79
10.5.1	General.....	79
10.5.2	Function deployment.....	79
10.5.3	New concept engineering and deployment.....	79
10.5.4	Parts deployment.....	79
10.5.5	Manufacturing and process deployments.....	79
10.5.6	Project work or task management.....	80
11	Design optimization.....	80
	Annex A (informative) Theory of Inventive Problem Solving (TRIZ).....	81
	Annex B (informative) Cross-reference between ISO 16355 and JIS Q 9025:2003(e).....	99
	Bibliography.....	123

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 8, *Application of statistical and related methodology for new technology and product development*.

A list of all parts in the ISO 16355 series can be found on the ISO website.

Introduction

Quality Function Deployment (QFD) is a method to ensure customer or stakeholder satisfaction and value with new and existing products by designing in, from different levels and different perspectives, the requirements that are most important to the customer or stakeholder. These requirements can be well understood through the use of quantitative and non-quantitative tools and methods to improve confidence of the design and development phases that they are working on the right things. In addition to satisfaction with the product, QFD improves the process by which new products are developed.

Reported results of using QFD include improved customer satisfaction with products at time of launch, improved cross-functional communication, systematic and traceable design decisions, efficient use of resources, reduced rework, reduced time-to-market, lower life cycle cost, improved reputation of the organization among its customers or stakeholders.

This document demonstrates the dynamic nature of a customer-driven approach. Since its inception in 1966, QFD has broadened and deepened its methods and tools to respond to the changing business conditions of QFD users, their management, their customers, and their products. Those who have used older QFD models can find these improvements make QFD easier and faster to use. The methods and tools shown and referenced in the standard represent decades of improvements to QFD; the list is neither exhaustive nor exclusive. Users can consider the applicable methods and tools as suggestions, not requirements.

This document is descriptive and discusses current best practice, it is not prescriptive by requiring specific tools and methods.

Applications of statistical and related methods to new technology and product development process —

Part 5: Solution strategy

1 Scope

This document describes the process of developing a solution strategy for new products. Since organizations can address their new product development process by a customer-driven or a technology-driven set of solutions, this document explains both alternatives. It provides recommendations on the use of the applicable tools and methods, offering guidance on translating the voice of the customer (VOC) and voice of the stakeholder (VOS) into product, service, information, and process attributes, transferring the priorities of the customer and stakeholder needs into priorities for these attributes, and then developing technology, cost, and reliability plans for attributes.

Users of this document include all organization functions necessary to ensure customer satisfaction, including business planning, marketing, sales, research and development (R&D), engineering, information technology (IT), manufacturing, procurement, quality, production, service, packaging and logistics, support, testing, regulatory, and other phases in hardware, software, service, and system organizations.

2 Normative references

The following documents are referred to in text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16355-1:2015, *Applications of statistical and related methods to new technology and product development process*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 16355-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Management summary

4.1 Basic concepts of QFD

The basic concepts of QFD are referenced in ISO 16355-1:2015, Clause 4.

4.2 Evolving classical QFD into modern QFD

4.2.1 General

QFD was first systematized in Japan in 1966 for applications in the automotive industry.[3] As new industries and applications emerged, the method, tools, and flow of information evolved to address the unique factors of each company. In recent years, the methods in 4.2.2 to 4.2.6 are most commonly used.

4.2.2 Classical QFD

Automotive component suppliers created a simplified flow that translated original equipment manufacturer (OEM) specifications into component specifications and process requirements using a series of four matrices, as follows:

- a) customer requirements into product requirements;
- b) product requirements into component requirements;
- c) component requirements into manufacturing requirements;
- d) manufacturing requirements into process requirements.

NOTE 1 Classical QFD is also called 4-phase QFD because of the four matrices used.[16] These four matrices are highlighted in yellow in [Figure 3](#).

NOTE 2 The 4-phase QFD charts in this document and ISO/TR 16355-8 use improved mathematics and tighter definitions to guide the user, resulting in faster implementation and more confident results.

4.2.3 Comprehensive QFD

The 4-phase QFD was readily adopted around the world for its simplicity and easy implementation. As QFD gained popularity, other industries, including finished goods, services, software and information systems, and processes struggled to make it fit their products and business models. This led adding more tools and flows to create a more comprehensive approach. Comprehensive QFD ensures the quality of new products by including market research to understand customer needs as referred to in ISO 16355-2 and ISO 16355-4, translating customer needs into design quality targets, and then deploying to innovation, cost, and reliability phases. It enables greater flexibility in application to a broad variety of industries including aerospace, architecture, construction, electronics, materials processing, services, and software.[1][24] The many tools and information flows enable the user to select which ones are applicable to their project. In [Figure 3](#), the vertical deployments are quality, technology, cost, and reliability. The horizontal deployments are customer, product, function, components, and build. The purpose of this document and ISO/TR 16355-8 is to guide users in harnessing the full capabilities of comprehensive QFD.

4.2.3.1 Quality deployment

[10.4.2](#) describes how product-independent customer needs are translated into functional requirements of the product, service, process, or information technology. Additionally, customer priorities and satisfaction targets are transferred into functional requirement priorities and performance targets, independent of the enabling technology. This technology independence allows for greater freedom of design in technology deployment. Functional requirements are then deployed to components, processes, and quality assurance.

4.2.3.2 Technology deployment

Either in response to unachievable product function and performance, or in engineering-driven innovation, technology deployment matches systems and subsystems to assess how well they achieve the prioritized functions and performance targets. This can trigger additional innovation efforts, refinement of technology concepts regarding user experience and interface, redirection of technologies

to more appropriate markets and customers, and establish criteria for technology assessment and selection, including costs. This is detailed in [10.4.3](#).

4.2.3.3 Cost deployment

As technologies are explored, the costs to develop and produce them must align with market price and business financial requirements such as revenues and profits. Selling price targets drive product cost targets which flow down to system, subsystem, component, and build cost targets. This flow down is managed through the tables and matrices in cost deployment. Since costs are absolute and not relative, the calculations in cost deployment matrices are more precise and are detailed in [10.4.4](#).

4.2.3.4 Reliability deployment

New technology increases risks related to many unknowns in actual customer usage, interactions with other systems provided by other suppliers, new materials, new software, and others. Risk of unknown failures can be, to some degree, forecasted based on known failures. Reliability deployment is detailed in [10.4.5](#).

NOTE 1 The comprehensive QFD charts in this document use improved mathematics and tighter definitions to guide the user, resulting in faster implementation and more confident results.

NOTE 2 Additional tools and methods have been added to comprehensive QFD such as strategic planning and market segmentation (referred to in ISO 16355-2), voice of customer translation into customer needs and improved mathematics (referred to in ISO 16355-4), and innovation and costing methods referred to in this document in [10.4.3.4](#) and [10.4.4](#), respectively.

NOTE 3 According to the scope of the project, a subset of these deployments and their associated tools can be required. Management awareness that such deployments exist helps improve their directives to product development teams, monitor their process, in order to increase their confidence in the results.

4.2.4 Matrix of matrices

A version of the comprehensive QFD models was developed to make the matrices easier to follow thought a systematic re-drawing of the information flows. It is called the matrix of matrices^[28] and displays the charts independent of each other. It is referenced in the standard when applicable.

4.2.5 Modern Blitz QFD®¹⁾

As modern businesses work to improve efficiency in a highly competitive global marketplace, the need for speed in new product development has emerged as an important constraint on QFD. The resources and time required for the classical and comprehensive approaches is not always feasible, and so a faster approach was developed by the U.S. QFD Institute called Blitz QFD® as shown in [Figure 2](#). The idea is to get the benefits of comprehensive QFD more quickly by focusing on only a small number of the highest priority customer needs. The emphasis on high priority customer needs requires additional analyses to ensure greater confidence in the prioritization process. Identifying high priority customers, semantic analysis, and situation analysis is explained in ISO 16355-2. Identifying high priority customer needs is explained in ISO 16355-4. Detailed design work is explained here in [9.2](#).

4.2.6 German QFD Institute model

This model includes several of the tools for market research, innovation, cost reduction, and reliability in the updated comprehensive QFD added to the classical 4-phase QFD. Many users find this a middle way through the other models.^[19]

1) Blitz QFD® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

5 Integration of QFD and product development methods

5.1 QFD support for product development methods

QFD support for product development methods is referenced in ISO 16355-1:2015, 5.1.

5.2 Flow of solution development with QFD

5.2.1 Organization of the QFD flow

The flow of QFD methods and tools can vary according to the organization and project requirements. Typically, they begin with broad concerns and through prioritization flow down to specifics. [Figure 3](#) shows the flow of product development from quality to technology to cost to reliability deployments.

5.2.2 Flow charts of strategy and translation of VOC into engineering solutions and cost planning

The detailed flow charts are presented in [Figure 2](#) and [Figure 3](#). These flow charts represent how the various tools in this document link together as a standard operating procedure that can be applied to individual projects. Not all tools are required on all projects. Custom tailoring of appropriate tools and sequence are recommended.

6 Types of QFD projects

QFD projects can encompass new developments as well as generational improvements to existing products. The types of QFD projects are referenced in ISO 16355-1:2015, Clause 6 and ISO 16355-4:2017, Clause 6, notes.

NOTE QFD tools and sequence have evolved since the first studies in the 1960s in the automobile parts industry that used simple diagrams and matrices to identify design elements and downstream manufacturing details. When end-user products, non-manufactured products such as service and software, and business processes began using QFD, additional tools were added to address human tasks, information, and other complexities (see [Figure 3](#)). In more recent years, organizational resource constraints have led to a quicker approach that addresses both complexity and speed (see [Figure 2](#)). It is consistent with quality methods in general and with customer-driven methods like QFD in particular that the methods and tools evolve and adapt to the ever-changing business environment of its practitioners, in order for them to remain viable and practicable. This evolution is demonstrated in the bibliography of case studies.

7 QFD team membership

7.1 QFD uses cross-functional teams

Cross-functional teams are referenced in ISO 16355-1:2015, 7.1.

7.2 Core team membership

Core team membership is referenced in ISO 16355-1:2015, 7.2.

7.3 Subject matter experts

Subject matter experts involvement is referenced in ISO 16355-1:2015, 7.3.

NOTE The matrix relationships and quantifications can be determined by the QFD team with representatives of customer-facing and technology-facing departments, such as marketing and operations or engineering. It is becoming more common with technology products for customers and stakeholders to be invited to participate, often in multiple meetings as the products are iterated. This is called continuous^{[18][20]} or collaborative QFD.^[54]

7.4 QFD team leadership

QFD team leaders or moderators can be trained in the QFD tools and methods in order to effectively lead the QFD project. Additional tools, as identified in the appendices can be useful. Basic team facilitation and moderation skills are recommended.

NOTE 1 The QFD team leader can take a position of being function-agnostic so as to remain neutral to any business department or activity.

NOTE 2 Team membership and responsibilities can be indicated according to the development process and functional departments and human resources. This can be detailed in a process map, supplier-input-process-output-customer (SIPOC) steps and inputs, or a cause-and-effect L-matrix.

EXAMPLE [Table 1](#) indicates the product development process in the rows and which departments or resources have what level of responsibility to the project.

Table 1 — QFD team responsibility L-matrix

Resource \ Process	Project owner	Finance	Marketing/Sales	R&D	Engineering	Supply chain	Manufacturing/Production	Logistics	Tech support
Strategize	●	◐	◐	◐	◐	◐	◐	◐	◐
Fund	◐	●	◐	◐	◐	◐	◐	◐	◐
Define customer problem	◐	◐	●	◐	◐	◐	◐	◐	◐
Define product solution	◐	◐	◐	●	◐	◐	◐	◐	◐
Develop	◐	◐	◐	◐	●	◐	◐	◐	◐
Test	◐	◐	◐	◐	●	◐	◐	◐	◐
Source/Supply	◐	◐	◐	◐	◐	●	◐	◐	◐
Build	◐	◐	◐	◐	◐	◐	●	◐	◐
Commercialize	◐	◐	◐	◐	◐	◐	◐	●	◐
Support	◐	◐	◐	◐	◐	◐	◐	◐	●
Retire	◐	◐	◐	◐	◐	◐	◐	◐	●

Key

- Primary responsibility
- ◐ Secondary responsibility
- ◐ Subject matter expert
- ◐ Support resource
- ◐ Keep informed

8 Seven management and planning tools

The use and purpose of the seven management and planning tools are referenced in ISO 16355-2:2017, 8.2.

9 Translation of one information set into another

9.1 General

QFD flows information sets through the various development and commercialization functions of the organization and design dimensions. These flows are called deployments and often require the language of one information set to be translated into another information set, or a single information set broken down into more detail. This translation can be visually displayed to check for completeness and accuracy, and can be mathematically quantified for complex information sets. The first transformation

is often from customer needs into product functional requirements, quality characteristics and capabilities, and specification values. There are two approaches to doing this,

- a) maximum value table, and
- b) L-matrices.

9.2 Maximum value table

9.2.1 General

The maximum value table is used to show everything on the project that is most important to the customers and stakeholders. It identifies where to apply best efforts to the tasks that are essential to delivering value to customers. By doing so, maximum value to customers results from minimum efforts by the QFD team.

9.2.2 Effect-to-cause diagram

Early QFD studies used an effect-to-cause diagram to show the relationship between product attributes and customer needs.^[39] Product attributes cause a customer need to be fulfilled. For each customer need, the QFD team can determine what product attributes, from development through commercialization are essential to delivering quality and satisfaction.

NOTE 1 The traditional cause-and-effect diagram (also known as Ishikawa diagram or fishbone diagram) is adapted in QFD to uncover the root causes of success rather than failure. It has two formats: cause-to-effect, which is explained in ISO 16355-4, and effect-to-cause. Note that the arrows point from one effect to many causal factors.

NOTE 2 The customer need is the effect. The names of causal bones and sub-bones depend upon the product. Technical staff with sufficient product knowledge can be invited to the QFD team to help identify them.

NOTE 3 Target values sufficient to meet the customer need can be determined by experimentation and testing as soon as possible.

NOTE 4 Each customer and stakeholder need can have a separate effect-to-cause diagram. Do high priority customer and stakeholder needs first. The analytic hierarchy process (AHP) can be used by customers and stakeholders to prioritize their needs.^{[48][17]}

EXAMPLE [Figure 1](#) is adapted from the first published QFD case study by Bridgestone Tire in 1966. It shows that the desired effect of smooth ride can be positively caused by proper design of the tire characteristics of tire trueness and sidewall strength, proper setting of the moulding process characteristics of pressure, time, and accurate fit of the mould halves, and proper raw material handling storage humidity and rotating the materials so that the oldest polymers are used first.

NOTE 5 The “head” of the fishbone diagram in QFD is oriented on the left side to indicate the flow of information from left-to-right as will be seen in the maximum value table in [9.2.3](#). This change in orientation better demonstrates the QFD matrix construction as a set of effect-to-cause diagrams with the heads becoming the rows of the matrix and bones becoming the columns.

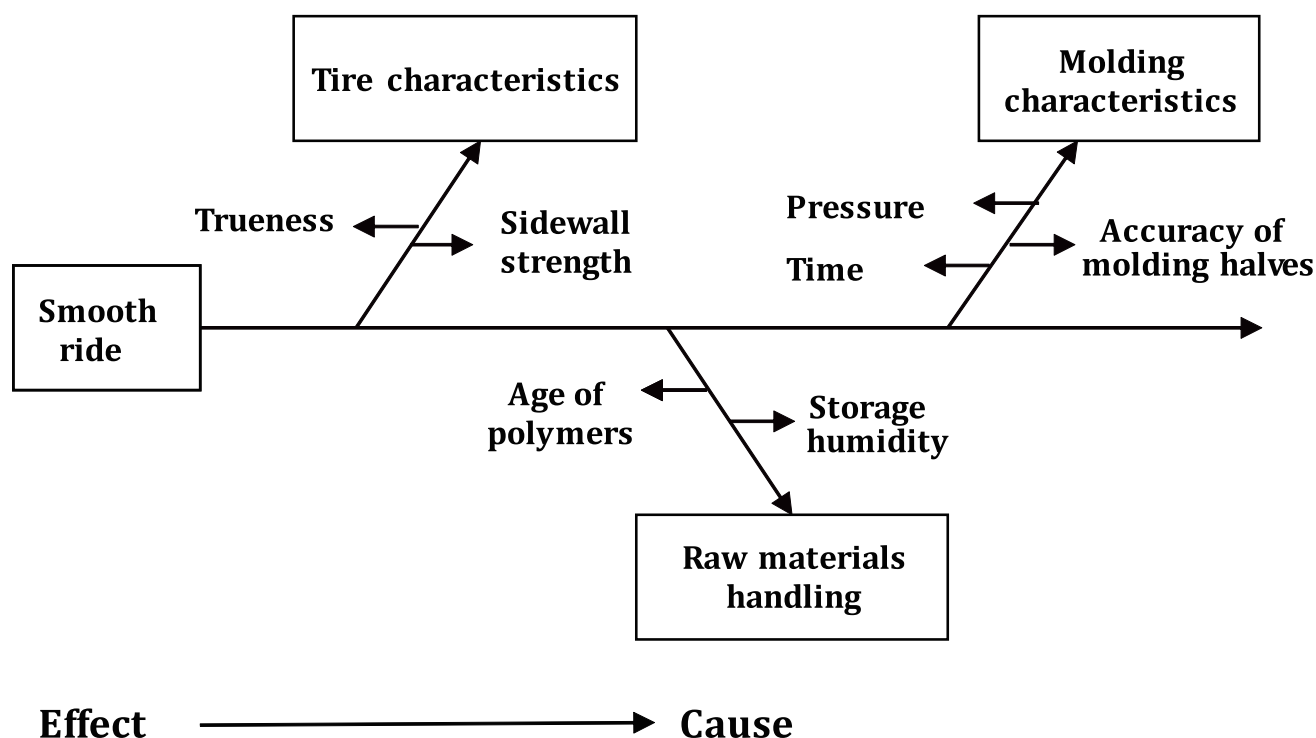


Figure 1 — Effect-to-cause diagram

9.2.3 Steps to make a maximum value table

The effect-to-cause diagram can be presented in a spreadsheet by putting the information into the columns. This is called the maximum value table.

- Enter information regarding the customer such as segment, application and use modes, problem, and other contexts that help the QFD team determine appropriate target values.
- Enter high priority customer and stakeholder needs. The analytic hierarchy process (AHP) can be used by customers and stakeholders to prioritize their needs.^{[17][48]}

NOTE 1 The number of needs to include depend upon the priorities of the needs as well as the project schedule, budget, and available resources. The guideline is to analyse only those needs for which the project can take action. Many projects can have only three to five high-priority needs.

- Identify the necessary design dimensions necessary to address the project. Make these separate column headers.
- For each high priority customer or stakeholder need, enter into the appropriate column any information, target values, tests to be done, and other relevant information as it becomes known. The maximum value table grows as the project progresses end-to-end throughout the development and realization process
- Indicate any special tasks related to this acquiring or acting on this information. Special tasks can be protected from de-scoping by the project manager in cases of budget or schedule conflict, as they are critical to addressing the most important customer or stakeholder needs.

EXAMPLE In Table 2, the highest priority customer need is my employees appreciate the benefits I provide to them.^[17] To fulfill this need and ensure that downstream service activities are performed sufficiently, the following must take place:

- contract should show savings to employee of using insurance;

- b) provider network (doctors and hospitals) should show their Blue Cross network is superior to care offered by competing provider networks;
- c) to communicate this, the sales broker or representative should explain exactly how the claims mechanism works;
- d) system should collect user feedback to ensure it works as promised;
- e) system level design should report employee savings and comparisons to street (uninsured) fees.

NOTE 2 Customer needs are transformed into product functional requirements which can include capabilities (technology-independent functions), quality and performance characteristics, and specification targets. In this example, which focuses on communication of information to the employees, only the capabilities of show savings, explain richness of benefits, and show employees how much employer paid are presented.

NOTE 3 The effort to develop and realize a solution strategy for the highest priority needs can consume the available budget, schedule, and human resources. The maximum value table helps ensure the highest value customer and stakeholder needs are addressed first and best. If available resources are consumed, this is possibly all the QFD the team can perform. All other customer and stakeholder needs can then receive standard engineering attention.

NOTE 4 QFD teams needing to address a larger set of customer and stakeholder needs can use an L-matrix to analyse two design dimensions at a time. The maximum value table is useful in determining which design dimensions warrant the L-matrix analysis.

NOTE 5 The maximum value table can be done early in the QFD study to analyse the solution to the most important customer or stakeholder needs. Even if other tools such as L-matrices are employed later, doing the maximum value table first can give the QFD team a head start on the critical needs.

NOTE 6 Maximum value tables from similar products or generations of products can be aggregated into comprehensive QFD L-matrices. This spreads the time and effort over several projects, eventually yielding the benefits of the deeper analysis of comprehensive QFD.

Table 2 — Maximum value table for health insurance company

Customer need	Solution				Design			Implementation
	Contract		Broker/ Representative	Operations		Feedback		
	Benefits	Provider network		Member service	Claims			
My employees appreciate the benefits I provide them.	Show savings to employee of using insurance	Explain to employees how Blue Card and BCBSF provider network is superior	Explain how benefits mechanism works			Assure benefits are working as promised and useful.	Employee savings report information	Expand PHR to include billing comparison to street rate.
	Explain richness of benefits offered through BCBSF	Employee does not have to change “critical” MD (pedia, OBGYN) to conform to plan	Explain to employees industry averages if employer is above average			Employees know they have a conduit for feedback	Provide customer advocate/ombudsman	
	Show employees how much the employer paid for their benefits		Explain network savings				Network savings report info	
							Report to summarize employer payments	
							Validate in PHR that decisions were good decisions (by staying in network/generics/etc.) or alternatives that would offer better outcomes/savings	
							Provide tools to employees that recommend plans based on current provider selections.	
							Provide tools to show employees what their costs would be for various benefit plans based on their experience.	

9.2.4 Modern QFD

The maximum value table can be used with other modern Blitz QFD® tools for analysing the voice of the customer and voice of the stakeholder. Guidance for the semantic analysis and situation analysis phases is explained in ISO 16355-2 and guidance for the goal analysis phase is explained in ISO 16355-4. The maximum value table is in the project strategy phase at the right in [Figure 2](#)^{[35][57]} and is positioned between the prior steps and the L-matrices used in comprehensive QFD.

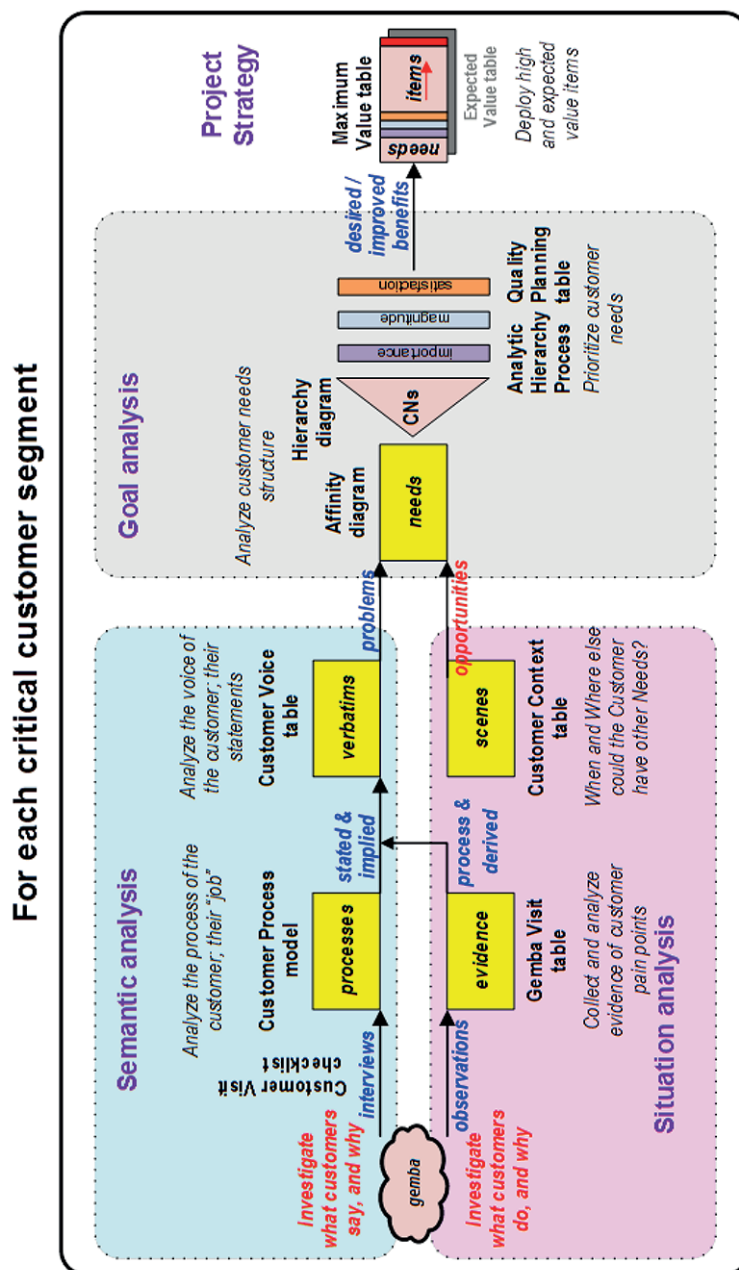


Figure 2 — Modern Blitz QFD® flow

9.3 L-matrices

9.3.1 General

The seven management and planning tools include several types of matrices. The most common matrix in QFD is the L-matrix which is used to examine two dimensions of information. L-matrices can be used

to examine goals and the means to achieve them, responsibilities, and relationships. The most common L-matrix in QFD is used to examine effect-to-cause relationships.

9.3.2 Entering information into L-matrices

When the row and column information sets are large, they can be organized with the affinity diagram and hierarchy diagram. Most common are three to four levels of primary, secondary, tertiary, and quaternary levels of abstraction. When building an L-matrix, the level of abstraction of the row can match the level of detail of the column. If mixed, the weight calculations of the matrix can have errors due to over- or under-counting relationships that are mismatched.

9.3.3 Determining effect-to-cause relationships in a QFD L-matrix

The QFD L-matrix is essentially a collection of effect-to-cause fishbone diagrams to show many effects to causes relationships. Effects are commonly placed in the rows of the matrix and causes in the columns. If this orientation is rotated, the effect-to-cause relationship can be preserved. The strength or contribution of a causal relationship can be indicated with words, symbols, or numbers. If the relationships between the effects and causes are subjective, then words and symbols are commonly used to indicate the strength or level of the relationship, as follows:

- a) classical QFD matrices use three levels of relationships described as weak (W), moderate (M), strong (S); symbols or icons used are:

Weak: $\triangle$ Moderate: $\circ$ Strong: $\odot$

NOTE 1 Strengths of this approach: familiarity. Weaknesses of this approach: with only three levels, QFD teams can struggle to agree on the appropriate level.

- b) modern QFD matrices use five or nine levels of relationships described as weak (W), moderate (M), strong (S), very strong (V), or extremely strong (X), as well as intervals such as weak-to-moderate (W-M), and so forth. These levels align with the analytic hierarchy process (AHP) that are used later to transfer priorities from the effects to the causes. Symbols or icons used are:

W $\circ$ W-M $\circ$ M $\circ$ M-S $\circ$ S $\circ$ S-V $\circ$ V $\circ$ V-X $\circ$ X $\bullet$

NOTE 2 Strengths of this approach: when the level of relationship requires a judgment, human short-term memory capacity is best when there are 7 ± 2 (5 or 9) levels. This allows first a judgment of high, medium, low, and then within each category another high, medium, low. This creates nine levels ranging from high-high to low-low, giving QFD teams more relationship levels to select from, and thus improving agreement. Weaknesses of this approach: unfamiliar but has a short learning curve, commercial QFD software cannot support these symbols.

NOTE 3 Certain symbol or icon patterns indicate the health of the matrix. For example, blank rows or columns indicate missing information. Nearly identical rows or columns indicate problems with comingled levels of abstraction of the row or column hierarchies.^[31]

NOTE 4 In addition to the L-matrix, QFD can use T-matrices, Y-matrices, C-matrices, and others in the seven management and planning tool set.^{[5][38][41]}

9.3.4 Linking matrices

Since each L-matrix relates two columns from the maximum value table, several matrices can be required to complete the QFD analysis. It is common that the columns of one matrix cascade into the rows of the next matrix in sequence. Thus, the matrices can be linked so that information flow downs and flow ups can be established such that changes in one matrix can be updated in later matrices. This can be useful if the matrices are later weighted with priorities and quantifications. A set of linked matrices can create a comprehensive QFD framework that can be used again on other projects.

9.3.5 Comprehensive QFD

In 1988, a comprehensive QFD model was developed that added to the quality deployment additional deployments to address issues related to technology, cost, and reliability. These deployments could be applied at the product level, system level, component level, and build level, as shown in [Figure 3](#).^[1] These deployments are explained in later clauses of this document.

NOTE 1 Comprehensive QFD is referred to in JIS Q 9025, 6.1.^[24]

NOTE 2 Comprehensive QFD was used as the model for the US-developed matrix of matrices.^[28]

9.3.6 House of quality

9.3.6.1 General

One of the most common L-matrices in QFD is the house of quality. The first published use of this matrix was in 1972 in Japan for a ship-building program. Later enhancements earned it the nickname “house” of quality due to its shape and several rooms.^[3] It is also referred generically as a quality table. In the comprehensive QFD flowchart in [Figure 3](#), the house of quality is located in the upper-left corner as Table 1-I. The house of quality is not shown in [Figure 2](#) but can be used after the maximum value table when greater detail is required.

9.3.6.2 Information for building the house of quality

The house of quality is so named for the several “rooms” or tables and the sometimes used “roof” that comprise it. These rooms, explained in this document and guidance for creating them, are as follows:

- a) customer needs hierarchy in the rows of the house of quality (in [9.3.6.2.1](#) and ISO 16355-4);
- b) functional requirements in the columns of the house of quality (in [9.3.6.2.2](#));
- c) customer needs — functional requirements matrix in the centre of the house of quality displays the strength of the contribution or relationship of each functional requirement to each customer need (in [9.3.6.2.3](#));
- d) quality planning table in the right-side room of the house of quality adjusts the priorities of the customer needs in response to customer satisfaction with current and competitors’ products, strategic product planning, and sales activities (in [10.3.2.1](#) and ISO 16355-4);
- e) design planning table in the basement of the house of quality adjusts the priorities of the functional requirements in response to competitive benchmarking, technical advantage, technical difficulty, and Kano dimensions of quality (in [10.3.4.1](#));
- f) functional requirements correlation matrix in the roof of the house of quality looks for conflicts and tradeoffs among the functional requirements that could impact design decisions (in [10.4.3.4.1.1](#)).

These rooms are assembled as shown in [Table 17](#).

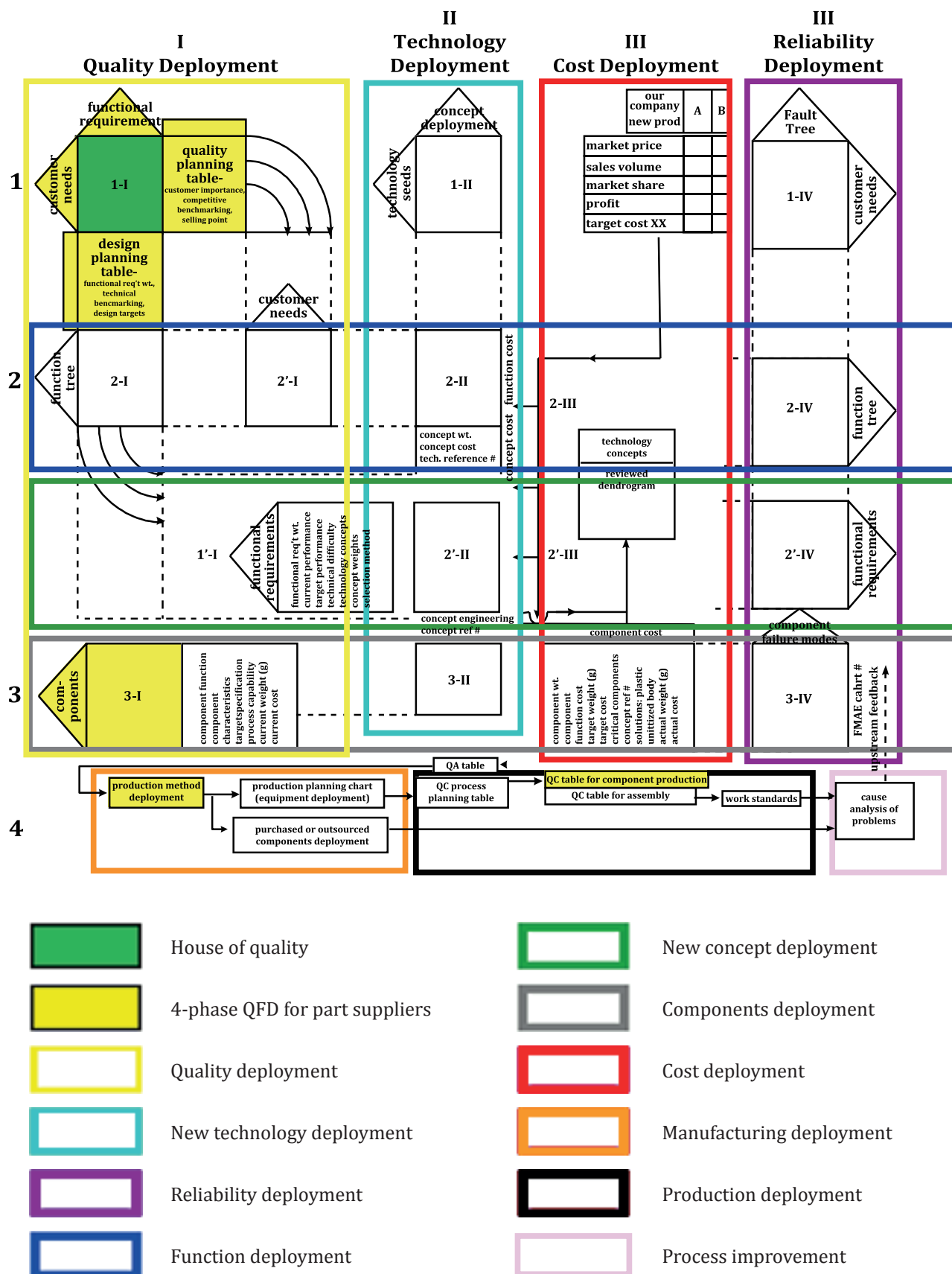


Figure 3 — Comprehensive QFD

9.3.6.2.1 Customer needs hierarchy diagram

In the rows of the house of quality are the customer needs. As noted in [Clause 3](#), customer needs describe the benefit to the customer of their problem solved, their opportunity enabled, or their image enhanced, independent of the product. Historically, these were called demanded quality items. The customer needs can be entered as a hierarchy diagram with only the most detailed level, usually tertiary level, being assigned relationships. This is explained in ISO 16355-4 in the customer voice table.

NOTE 1 In QFD, the voice of customer is sometimes referred to as requirements because it comes directly from the customer. Requirements can include a raw mix of needs, solutions, and features. However, it is important to understand why the customer has specified these requirements, and so the customer voice table in ISO 16355-4 explains how to translate voice of customer requirements into true customer needs. Getting the underlying customer needs has two benefits. One, customers can prioritize them more accurately and two, they more clearly separate the problem space from the solution space which can lead to more innovative solutions. Another confusing term, “wants and needs,” actually refers to priorities with needs having a higher priority than wants. In QFD, these priorities are clearly calculated using the AHP process explained in ISO 16355-4.

NOTE 2 In [Figure 3](#), the customer needs hierarchy is represented as a triangle on the left side of the matrix. It is not a correlation matrix or trade-off matrix, since customer needs have priorities, not conflicts.

9.3.6.2.2 Functional requirements hierarchy diagram

In the columns of the house of quality are the functional requirements. Historically, these were called quality characteristics, but to make QFD easier to apply in non-manufacturing applications, the more universal term functional requirements has been adopted. As noted in [Clause 3](#), functional requirements describe what the product is or does without defining how it does it. Thus, they can be technology-independent. Functional requirements can already be known by the QFD team or can be extracted from each customer need using an effect-to-cause diagram. If possible, determine the method of measuring each functional requirement to ensure that measurable targets can be set. Functional requirements can be structured with an affinity diagram and a hierarchy diagram. Affinity and hierarchy diagrams are explained in ISO 16355-4.

NOTE Some QFD users use the terms customer needs for the rows and product requirements for the columns. Product requirements can include both functional requirements and non-functional requirements. Non-functional requirements such as aesthetics are described in ISO/TR 16355-8. In value engineering, however, non-functional requirements such as aesthetics are called attractive functions.

EXAMPLE In [Figure 4](#), notice the arrows come out of the customer need from the customer need “I can get a taste I like” (head of fishbone diagram) and point to the functional requirements (bones). [Figure 5](#) and [Figure 6](#) illustrate the structuring of the functional requirements.

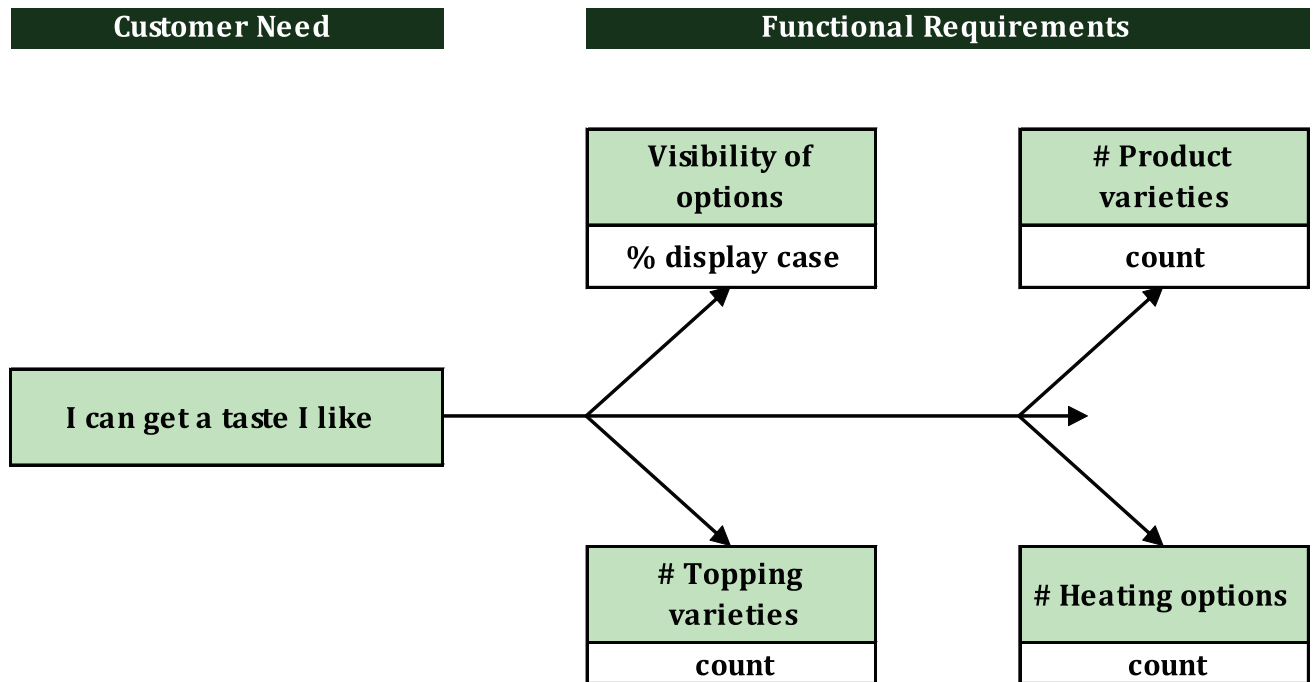


Figure 4 — Fishbone diagram used to extract functional requirements from customer needs in airport breakfast kiosk

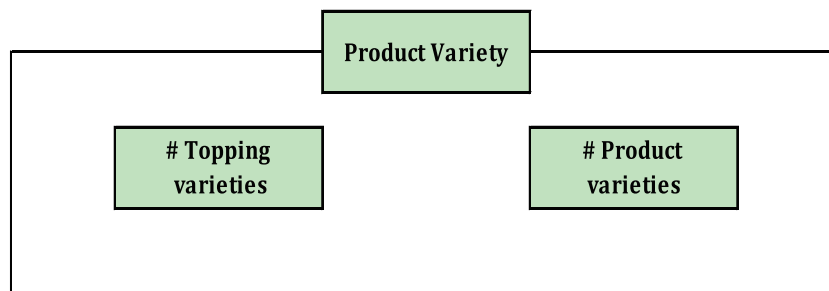


Figure 5 — Affinity diagram of functional requirements in airport breakfast kiosk

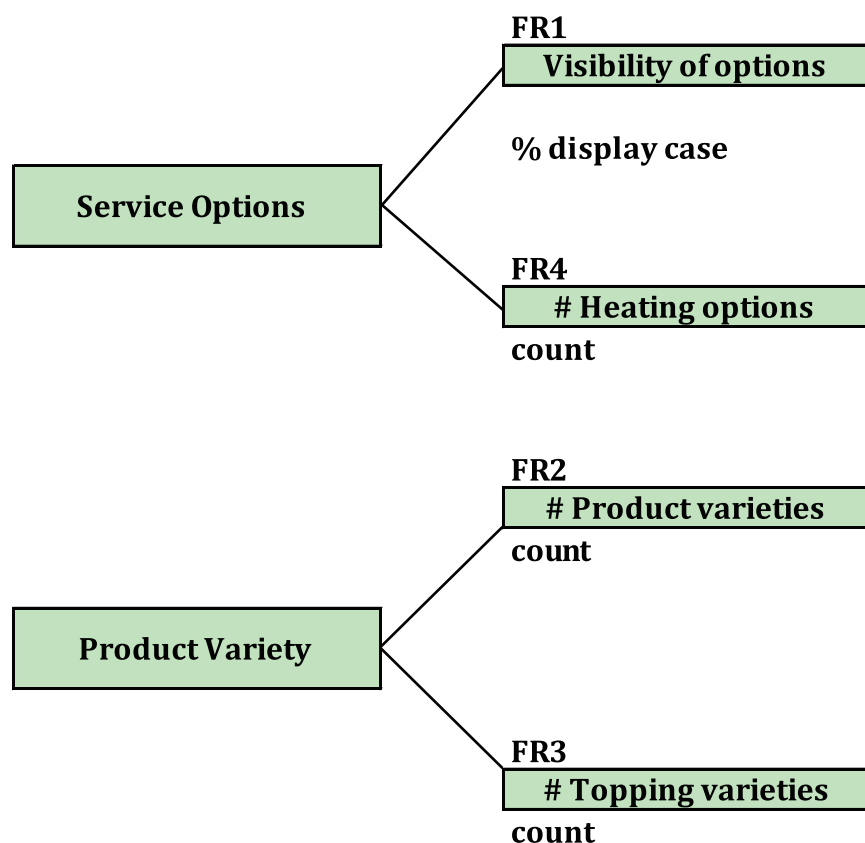


Figure 6 — Hierarchy diagram of functional requirements in airport breakfast kiosk

9.3.6.2.3 Matrix

Functional requirements are entered into the columns of an L-matrix, matching the same level of detail as the customer needs. Working row-by-row, the strength of contribution or relationship of each functional requirement noted in the intersecting cells of the matrix. The strength of contribution or relationship is explained in [10.2.1](#).

NOTE 1 In [Figure 3](#), the functional requirements hierarchy is represented as a triangle on the top of the matrix. It is not a correlation matrix or trade-off matrix since these arise only in technology specific characteristics or attributes.

NOTE 2 Historically, this is the only matrix to have the term quality in both the rows and columns, thus earning it the nickname “house of quality.” The modern approach is to name matrices by the names of their information sets. Thus, the house of quality can be referred to as the customer needs-functional requirements matrix. This avoids confusion of the many matrices in comprehensive QFD.

NOTE 3 Normally, each functional requirement has a relationship with more than one customer need. In some cases, increasing the performance of the functional requirement helps achieve the customer need, in other cases, meeting a target value of the functional requirement helps achieve the customer need, and in still other cases reducing the performance of the functional requirement helps achieve the customer need. For example, increasing the size of an umbrella helps achieve the customer’s need to stay dry in the rain, but decreasing the size of an umbrella helps achieve the customer’s need to carry it easily. Therefore, functional requirements do not have direction until setting targets in the design planning table discussed in [10.3.4.3](#).

NOTE 4 Functional requirements are referred to in JIS Q 9025, 5.4.2.[\[24\]](#)

NOTE 5 The functional requirements correlation matrix, often referred to as the “roof” of the house of quality is most useful to examine for positive (as one functional requirement improves, so does another) or negative correlations (as one functional requirement improves, another is reduced), after an enabling technology is selected. Since the positive or negative correlations are technology dependent (change the enabling technology and the correlations change), doing this matrix can prematurely imbed a solution paradigm into the analysis, thus limiting the QFD team’s ability to innovate.

EXAMPLE Table 3 is an example of an unweighted matrix. This matrix shows that the customer need of I can make a healthy choice is moderately achieved by making the food and preparation options visible, strongly achieved by having a number of product varieties, and strongly achieved by having a number of topping varieties. Number of heating options as no impact.^[30]

Table 3 — Customer needs-functional requirements matrix (house of quality) for airport breakfast kiosk (unweighted)

Functional Requirements (for service) Customer Needs		Visibility of options	# Product varieties	# Topping varieties	# Heating options
		SR1	SR2	SR3	SR4
1.1.1	I can make a healthy choice				.
1.1.2	I can get a taste I like				
1.1.3	I can make an appealing choice				
1.1.4	I can choose quickly				

9.3.7 Knowledge management

Unweighted L-matrices are also useful in knowledge management to capture intrinsic or “tribal” knowledge of individuals in the organization.^[2] Information in L-matrices can later be weighted for a specific project. This can be valuable in the following scenarios:

- mature organizations whose engineering technology and methods are poorly documented;
- organizations facing employee turnover due to retirements, short-term project work, mergers and acquisitions;
- organizations expanding their technical staff. Knowledge management matrices can be helpful in training new hires.

10 Transfer of prioritization and quantification from one information set into another

10.1 General

Prioritizations and quantifications of one information set can be transferred into prioritizations and quantifications of another information set. This is used to flow the results of each analytic tool into the

next tool in order to ensure that upstream priorities and targets are deployed downstream into solution priorities and targets. In a QFD L-matrix, prioritization builds on relationships that show the strength of relationship or contribution of the columns of the matrix to the rows of the matrix as explained in [9.3.3](#).

NOTE Typically, the transfer of prioritization and quantification are done by the QFD team, involving both customer facing (marketing, sales, product managers) and technology facing (R&D, engineering, and others) members.

10.2 Transfer of prioritization

10.2.1 Quantify strength of relationships in the matrix

There are different approaches to quantifying the weights of contributions or strengths of relationships in a matrix. An approach that is appropriate for the analysis can be used.

- a) Classical QFD matrices using three levels of relationships described as weak (W), moderate (M), strong (S) and assigned values of 1, 2, 4 or 1, 3, 5 or 1, 3, 9 respectively.

NOTE 1 Strengths of this approach: familiarity, 1, 3, 9 addresses problem of transferred priorities being too close in value. Weaknesses of this approach: with only three levels, QFD teams can struggle to agree on the appropriate level, these are ordinal scales without fixed intervals so that resulting QFD math functions have results that only tell order but not relative importance.

- b) Modern QFD matrices use five or nine levels of relationships described as weak (W), moderate (M), strong (S), very strong (V), or extremely strong (X), as well as intervals such as weak-to-moderate (W-M), and so forth. Assigned values can be adapted using the analytic hierarchy process, but the following are commonly used.

Five levels: W (0,069), M (0,135), S (0,267), V (0,518), X (1,00)

Nine levels: W (0,059), W-M (0,079), M (0,112), M-S (0,162), S (0,237), S-V (0,344), V (0,498), V-X (0,712), X (1,000)

NOTE 2 Strengths of this approach: When the level of relationship requires a judgment, human short-term memory capacity is best when there are 7 ± 2 (5 or 9) levels. This allows first a judgment of high, medium, low, and then within each category another high, medium, low. This creates nine levels ranging from high-high to low-low, giving QFD teams more relationship levels to select from, and thus improving agreement. These ordinal judgments are transformed into absolute scale values with fixed intervals using the AHP principle eigenvector, so that resulting QFD math functions tell both order and relative importance. Weaknesses of this approach: unfamiliar but has short learning curve, if commercial QFD software does not support assigning ratio scale values, QFD team can build its own spreadsheet.

- c) Nonlinear relationships can be used in cases where other scales are justified.
- d) Technical L-matrices can use the formula $Y = f(x_1, x_2, \dots, x_n)$. Where measureable data exists between the input (x) and output (y), the Pearson product moment correlation coefficient can be used to measure the degree of linear relationship between the two variables. The correlation coefficient assumes a value between -1 and +1. If one variable tends to increase as the other decreases, the correlation coefficient is negative. Conversely, if the two variables tend to increase together the correlation coefficient is positive. However, in most QFD L-matrices such as the house of quality, the absolute value of the correlation can be used so that when column values are summed, positive and negative correlations do not cancel each other out but rather add to indicate a higher priority.
- e) Display of relationships or contribution can include icons representing the various levels. Icons can visually increase according to the strength of relationship or contribution they reflect, from weak to extremely strong, as shown in [9.3.3](#).

10.2.2 Weight the rows

10.2.2.1 Customer need priorities

ISO 16355-4 explains how to get prioritized customer needs in the form of a hierarchy. Priorities can be as accurate, unbiased, and unambiguous as possible as they can serve later QFD activities related to cost and resource allocation. Thus, the mathematical limitations of different numerical scales cannot be ignored.

NOTE 1 Prioritization can be done by the group that “owns” the information. For example, customer needs can be prioritized by the customer.

NOTE 2 The analytic hierarchy process (AHP) enhances the precision of the statistical methods of QFD by employing absolute relative scale values with meaningful ratios that can be added, subtracted, multiplied, and divided.^[48] AHP also gives customers a forced-choice, paired comparison model that yields more accurate results. Finally, when applied to a hierarchy, the prioritization process is broken into smaller groups which is less fatiguing than presenting customers with single, long list of needs to rate on an ordinal scale.

NOTE 3 Ordinal scale values do not contain sufficient information to perform QFD mathematical functions properly. There are these problems.

- a) The ratios between the levels are not equal; the effort to go from 1 to 2 is 100 %, while the effort to go from 4 to 5 is only 25 %. In ratio scale, the ratios between the scale values are close to equal.
- b) Because of the inequality or ratios, ordinal scales tend to bias towards the higher values.
- c) Ordinal scale values cannot be divided, nor can most other mathematical functions be performed. Ordinal numbers do support mode and median, which is why early QFD studies recommended using response mode (most frequent count) rather than mean (average) response.

NOTE 4 Those preferring 1–5 scale surveys can still survey with ordinal numbers. However, before any mathematical functions are performed, such as averaging, the responses can be converted to ratio scale. The five level ratio scale shown in 10.2.1 b) can be used as follows. 1 (0,069), 2 (0,135), 3 (0,267), 4 (0,518), 5 (1,00).

10.2.2.2 Cascading linked matrix priorities

In comprehensive QFD as shown in Figure 3, matrices can be linked together so that the columns of one matrix cascade into the rows of the next matrix in the sequence. Similarly, the column weights of one matrix can be cascaded into the row weights of the next matrix in the sequence. This is important for transferring the information sets and priorities from customer needs through functional requirements into quality, technology, cost, and reliability factors as shown in Figure 3 and detailed later in this document.

NOTE 1 If only a subset of columns are cascaded into the next matrix in the sequence, those weights can be normalized to 100 % before cascading. This keeps downstream weights from displaying too many zeros after the decimal and thus making their priorities more difficult to recognize. Ratio scale weights can be used or downstream weights can lose accuracy.

NOTE 2 Avoid confusion by not referring to rows as “whats” and columns as “hows” in all the matrices. In fact, the rows of the house of quality (customer needs) are “why” the customer wants the product and the columns are “what” the product must be or do (functional requirements). Functional requirements specifically do not include “how” to do it.

NOTE 3 If the effect-to-cause orientation of rows-to-columns is rotated as in some of the matrices in Figure 3, then the cascading matrix weights can also be rotated so that the row weights cascade to the columns of the next matrix in the sequence.

EXAMPLE Table 4 shows the flow of information and priorities from columns of one matrix to rows in the next matrix in the sequence. In this example, the columnar functional requirements for service and their weights at the bottom flow into the rows of the next matrix which is the functional requirements (for service)-function matrix. This example is explained in detail in 10.4.2.4.3.

Table 4 — Cascading linked matrices for airport breakfast kiosk

Functional Requirements			Priority (from unweighted QP1)	Visibility of options FR1	# Product varieties FR2	# Topping varieties FR3	# Heating options FR4
Customer Needs							
1.1.1	I can make a healthy choice	19,3%					
1.1.2	I can get a taste I like	60,6%					
1.1.3	I can make an appealing choice	11,6%					
1.1.4	I can choose quickly	8,6%					
weighted	Absolute Weight		0,324	0,425	0,237	0,091	
	Functional Requirement Weight		30,1%	39,5%	22,0%	8,4%	
	Functional Requirement Rank		2	1	3	4	

Functions			FR weights			
Functional Requirements (for service)						
SR1	Visibility of options	30,1%				
SR2	# Product varieties	39,5%				
SR3	# Topping varieties	22,0%				
SR4	# Heating options	8,4%				
weighted	Absolute Weight		0,324	0,425	0,237	0,091
	Function Weight		30,1%	39,5%	22,0%	8,4%
	Function Rank		2	1	3	4

COMMISSARY				OPERATIONS			
Source Product FN1	Acquire Product FN2	Prepare Product FN3	Ship Product FN4	Finish Preparation FN5	Sell Product FN6	Display Product FN7	Maintain Product FN8
0,071	0,071	0,071	0,071	0,150	0,000	0,301	0,150
0,395	0,395	0,094	0,395	0,044	0,094	0,395	0,395
0,220	0,220	0,052	0,220	0,052	0,052	0,052	0,052
0,020	0,020	0,000	0,000	0,000	0,020	0,000	0,000
0,706	0,706	0,217	0,686	0,246	0,166	0,748	0,597
17,3%	17,3%	5,3%	16,9%	6,0%	4,1%	18,4%	14,7%
2	2	7	4	6	8	1	5

10.2.3 Calculate the column weights

Transfer of priorities from rows to columns can be calculated as:

$$W_j = \sum_{i=1}^n X_i a_{ij} \quad (1)$$

where

X_i is the priority of the row item (for example, customer need priority in the house of quality);

a_{ij} is the strength of the relationship between the row and the column.

NOTE 1 Because ordinal scale weights such as 1,2,4 or 1,3,5 or 1, 3, 9 do not support mathematical functions such as addition, subtraction, multiplication, or division, ratio scale weights described in 10.2.1 b) can be used.

EXAMPLE Table 5 adds relationship weights to Table 3. Working the first customer need I can make a healthy choice, it has a customer priority of 19,3 % derived from the unweighted quality planning table explained in part four of the standard (ISO 16355-4). Functional requirement visibility of options has a moderate relationship contributing to achieving this need. A moderate relationship is indicated by the quarter-pie symbol or icon, and it has a relationship weight of 0,112 as shown in 10.2.1 b). Multiply the customer need weight of 19,3 % $\times$ 0,112 = 0,022 rounded to three decimals. This is shown in the lower-right portion of the split cell. This is repeated for all relationships. The values in the lower-right portions of the split cells are then summed for each column to calculate an absolute weight. Thus, 0,022 + 0,143 + 0,116 + 0,043 = 0,324 rounded to three decimals. The absolute weights are then summed across: 0,324 + 0,425 + 0,237 + 0,091 = 1,077 rounded to three decimals. The absolute weights are then normalized into functional requirement weights by dividing each absolute weight by the sum of all absolute weights. Thus, 0,324/1,077 = 0,301 or 30,1 % rounded to three decimal places. If desired, rank order can be displayed as shown here.

NOTE 2 The use of split cells is optional. Specialized QFD software can display this easily, but most QFD software does not support ratio scale numbers, without which these calculations lose accuracy. Another solution is to use a spreadsheet and just show the relationship strengths as ratio scale values. The spreadsheet function `sumproduct` can be used to calculate an array of the row weights $\times$ the relationship strengths in the cells, and then sum the products as absolute weights.

NOTE 3 This example is the house of quality showing customer needs and functional requirements. The math calculations shown here apply to all QFD L-matrices. There are three methods of calculations depending on the distribution method described in 10.2.4. Table 5 uses the ideal distribution. If cost deployment is going to be used later in the QFD, then the proportional distribution method is recommended.

Table 5 — Customer needs-functional requirements matrix (house of quality) for airport breakfast kiosk (weighted, ideal distribution)

Functional Requirements			Customer Needs			
			Priority (from unweighted QPT)			
			FR1			
			FR2			
			FR3			
			FR4			
1.1.1			0,022	0,046	0,046	0,000
1.1.2			0,143	0,302	0,143	0,068
1.1.3			0,116	0,058	0,027	0,013
1.1.4			0,043	0,020	0,020	0,010
weighted			0,324	0,425	0,237	0,091
			30,1%	39,5%	22,0%	8,4%
			2	1	3	4

10.2.4 Distribution methods

10.2.4.1 Use of scales

The mathematical calculations in the various distribution methods require addition, multiplication, and division. To preserve the accuracy of these calculations, ratio scale values can be used for row weights and relationship strengths as described in 10.2.1 b).

10.2.4.2 Independent distribution

Independent distribution treats each column independently of the other columns, so that no single column can dilute the others. In QFD, this is the most common distribution method. This identifies which columns are most critical and can be investigated further. For example, in the house of quality, functional requirements are prioritized and the most critical can be investigated first.

10.2.4.3 Ideal distribution

Ideal distribution yields the same column priorities as independent distribution, but the scale maximum is set to 1,000 and all other relationship strengths are represented in ratio to 1,000. This is the method used in [Table 5](#).

NOTE Since independent and ideal distributions yield the same column priorities, the distribution method easiest for the QFD team can be used. When using the ideal distribution, be careful not to confuse a relationship value of 1,0 with a statistical correlation of 1,0 which would erroneously imply that one column completely explains the row.

10.2.4.4 Proportional distribution

Proportional distribution is used when the number and strengths of the correlations in each row are important to consider. It normalizes each relationship row-by-row. This is useful when there is a limiting factor to consider, such as cost, weight (mass), time, or human resource. The row weight is then proportioned by the relationship weights to the columns. This is useful when all columns must all be considered. For example, a cost plan must assign a target cost to each system, subsystem, and component in proportion to its contribution to the function of the product.

NOTE Independent and proportional distribution is referred to in JIS Q 9025, 5.2.3.[\[24\]](#)

EXAMPLE 1 The airport breakfast kiosk example is repeated here but in proportional distribution. To simplify, the relationship strengths have been displayed as numbers instead of the symbols, as in [Table 5](#). For example, the relationship between I can make a healthy choice and visibility of options is a moderate relationship which has a ratio scale value of 0,162 as shown in [Table 6](#). The ratio scale values are entered in all intersecting cells. Each row is then summed across, thus $0,112 + 0,237 + 0,237 + 0,000 = 0,586$. Numbers are rounded to three decimal places.

**Table 6 — Customer needs-functional requirements matrix for airport breakfast kiosk
(displaying relationship weights as numbers)**

Functional Requirements (for service)	CN Wt.	Visibility of ptions	# Product varieties	# Topping varieties	# Heating options	Row sum of SR
		SR1	SR2	SR3	SR4	
I can make a healthy choice	19,3 %	0,112	0,237	0,237	0,000	0,586
I can get a taste I like	60,6 %	0,237	0,498	0,237	0,112	1,084
I can make an appealing choice	11,6 %	1,000	0,498	0,237	0,112	1,847
I can choose quickly	8,6 %	0,498	0,237	0,237	0,112	1,084

EXAMPLE 2 The ratio scale values of the relationships are then normalized by dividing each intersecting cell value by its row sum, as shown in Table 7. The row sum of the normalized relationships equals 1,00, thus $0,191 + 0,404 + 0,404 + 0,00 = 1,00$. Numbers are rounded to three decimal places.

**Table 7 — Customer needs-functional requirements matrix for airport breakfast kiosk
(displaying normalized relationship weights)**

Functional Requirements (for service)	CN Wt.	Normalized				Row sum of SR
		Visibility of options	# Product varieties	# Topping varieties	# Heating options	
Customer Needs		SR1	SR2	SR3	SR4	
I can make a healthy choice	19,3 %	0,191	0,404	0,404	0,000	1,000
I can get a taste I like	60,6 %	0,218	0,460	0,218	0,103	1,000
I can make an appealing choice	11,6 %	0,541	0,270	0,128	0,061	1,000
I can choose quickly	8,6 %	0,460	0,218	0,218	0,103	1,000

EXAMPLE 3 The ratio scale values of each relationship is then multiplied by the row weight (customer need weight in house of quality). These products are then summed and normalized to a percentage column weight (functional requirement weight in house of quality), as shown in Table 8. Thus $0,191 \times 19,3 \% = 0,037$. For SR1, the functional requirement weight is calculated as $0,037 + 0,132 + 0,063 + 0,039 = 0,271$ or 27,1 %. Numbers are rounded to three decimal places. Because the relationship weights were normalized already, the absolute weight and column weight (functional requirement weight in the house of quality) are the same.

**Table 8 — Customer needs-functional requirements matrix for airport breakfast kiosk
(displaying row weight × relationship weights, summed and normalized)**

Functional Requirements (for service) Customer Needs	CN Wt.	Visibility of options	# Product varieties	# Topping varieties	# Heating options
		SR1	SR2	SR3	SR4
I can make a healthy choice	19,3%	0,037	0,078	0,078	0,000
I can get a taste I like	60,6%	0,132	0,278	0,132	0,063
I can make an appealing choice	11,6%	0,063	0,031	0,015	0,007
I can choose quickly	8,6%	0,039	0,019	0,019	0,009
Absolute Weight		0,271	0,406	0,244	0,079
Functional Requirement Weight		27,1%	40,6%	24,4%	7,9%

10.3 Transfer of quantification

10.3.1 General

Quantification is used to set target values or specifications for the column information that ensures the target values or specifications of the row information can be met. How to achieve the target values of specifications of the columns could be known or not known yet, and are analyzed further in subsequent matrices in the sequence.

10.3.2 Quantify row information

10.3.2.1 Use of pre-existing quantification information

In many cases, the quantification of row information can be done in a previous step such as in a table or matrix preceding the current matrix in the sequence. In some cases, the pre-existing quantifications can be prioritized or not. Quantification information can include target values, specifications, competitive information, and other relevant details.

EXAMPLE [Table 9](#) (from ISO 16355-4) displays quantifications for the row information. For the customer needs-functional requirements matrix (house of quality), this can come from the unweighted or weighted quality planning table described in ISO 16355-4. In this example, the target value for I can get a taste I like with a priority of 60,6 %, includes a target value of something delicious enough to beat the competitive offering of food from a professional kitchen. This information came from gemba visits and customer interviews.

Table 9 — Unweighted quality planning table for airport breakfast kiosk

CN#	Customer	information	Current situation		Hoped for situation		Competitiveness		Kano
		Importance	Magnitude of current performance level	Satisfaction with current performance level	Magnitude of hoped for performance level	Satisfaction with hoped for performance level	Magnitude of Competitor	Selling Point Potential if hoped for level	
	Key Customer Needs	From Renormalized CN Hierarchy diagram							Prediction of Kano Category
1.1.1	I can make a healthy choice	19,3%	only junk food	Dissatisfied	at least one healthy choice	Neutral	protein bar	minor	Expected
1.1.2	I can get a taste I like	60,6%	OK	Neutral	delicious	Very satisfied	professional kitchen	major	Exciting
1.1.3	I can make an appealing choice	11,6%	nothing looks good	Neutral	local specialty	Very satisfied	professional kitchen	minor	Exciting
1.1.4	I can choose quickly	8,6%	don't know if time to choose meal	Dissatisfied	at gate at 1st boarding call	Neutral	onboard snack box	none	Expected

10.3.2.2 Creation of new quantification information

When quantification is necessary and pre-existing quantification information is insufficient, new quantification information can be created by conjecture subject to discussion or surveys with customers and stakeholders, or other means of validation.

10.3.3 Use relationship weights to connect row quantification to column quantification

The logic of QFD L-matrices is that if there is a high priority row, the columns with strong relationships with that row can also be high priority. Further, quantifications of the high priority rows can indicate a problem, deficiency, or opportunity with the current level of performance of the row and consequently a corresponding problem, deficiency, or opportunity with the current level of performance of the strongly related columns.

EXAMPLE In [Table 5](#), the highest priority row, I can get a taste I like (60,6 %) has a very strong relationship with # product varieties. The row quantification of delicious enough to beat a professional kitchen can create a corresponding opportunity to improve the # product varieties to better than what would be offered by a professional kitchen.

10.3.4 Quantify column information

The quantification information for columns can come from hypotheses subject to discussion or surveys with customers and stakeholders, experimentation, test, technical benchmarking or teardowns, prototype, or other means of validation. It can include additional information related to competition, technical difficulty, or other important decision factors. Target values or specifications can reflect what performance is sufficient to fulfill the strongly related customer needs and exceed the competitive alternatives.

NOTE 1 If specifications or targets are technically difficult, this can trigger innovation or creativity efforts to resolve the difficulty, or tradeoff decisions to optimize any technical conflicts. These are addressed elsewhere in this document.

NOTE 2 The customer needs-functional requirements matrix (house of quality) has a unique column information table that corresponds to the row information table (quality planning table). The column information table is called the design planning table.

10.3.4.1 Design planning table information for the house of quality

10.3.4.2 General

The design planning table is used in the house of quality to help the QFD team set target specifications needed to fulfill high priority needs better than the competition. The design planning table can be unweighted information only or can be additionally weighted to adjust the column prioritizations.

NOTE 1 Which information to use in the design planning table is optional, according the project.

NOTE 2 Since the effort to obtain accurate information is not trivial, the QFD team can elect to analyse only the highest priority functional requirements.

10.3.4.3 Unweighted design planning table

Common information displayed in the design planning table includes the following, as shown in [Table 10](#).

Table 10 — Unweighted design planning table for airport breakfast kiosk

Functional Requirements (for service)			Visibility of options	# Product varieties	# Topping varieties	# Heating options
			SR1	SR2	SR3	SR4
Customer	Priority		30,1 %	39,5 %	22.0 %	8,4 %
technical evaluation	performance	current	10 % display	2	3	0
		competitor	5 % menu	2	2	1
		target	60 % am display	6	5	1
Relative to Competition	Judgment		Much Better	Much Better	Better	Equal
Technical Challenge	Judgment		None	Minor	Minor	Major
Technical Advantage	Judgment		Minor	Major	Minor	None
Kano	Survey		Exciting	Exciting	Expected	Expected

a) Functional requirements and their priorities from the house of quality.

EXAMPLE 1 [Table 10](#) brings over the functional requirement priority weights of 30,1 % for visibility of options, 39,5 % for # product varieties, 22,0 % for # topping varieties, and 8,4 % for # heating options.

- b) Performance levels of the current product and competitive products, corresponding to the competitors in the quality planning table.

EXAMPLE 2 [Table 10](#) shows that the level of visibility of options is 10 % of the display case and the competitor which has a traditional menu devotes about 5 % to breakfast items. Number of bagel (a type of breakfast roll) varieties is currently 2 and the competitor is also 2.

- c) A performance target or specification sufficient to meet the strongly related customer needs and to beat the competition to a degree that the customer would consider purchasing the new product, despite the costs associated with a new purchase, learning curve, operator and service training, and other factors required to change from the existing product to the new one.

EXAMPLE 3 [Table 10](#) shows a target value of 60 % of the display case can be devoted to breakfast items during the morning. The number of bagel varieties can be increased to 6.

NOTE 1 The performance target takes into account the operating environment of the target customers identified earlier in the QFD study, as explained in ISO 16355-2. For example, in the design of a hand-held light or torch, a reduction in weight (mass) of the light from 100 g to 98 g is probably insignificant if the target customer is a camper in the campground. If the target customer is an astronaut in a space vehicle or station, however, a two gram reduction in weight can lower launch costs by as much as € 1 000. Performance target optimization and competitive benchmarking is explained in detail in ISO 16355-6.

NOTE 2 If the current performance of a functional requirement strongly related to a high priority customer need already exceeds the competition, it can indicate that neither product is sufficient to meet the customer need.

NOTE 3 If the current performance of a functional requirement strongly related to a high priority customer need already exceeds the competition, it can indicate that there is a problem with marketing or advertising the current product. This means that the customer perception captured in the quality planning table of the competitor's product being superior is contradicted by the actual performance of the product. This means that the customer perception is misled either by insufficient advertising of the product or confusing advertising by the competition.

- d) Judgment relative to competition can be useful in capturing the QFD team's opinion about whether the performance target can enable a marketing or advertising campaign.
- 1) If the strongly related high priority customer need has a major selling point in the quality planning table, there can be a judgment of much better relative to the competition.
 - 2) If the strongly related high priority customer need has a minor selling point in the quality planning table, there can be a judgment of better relative to the competition.
 - 3) If the strongly related high priority customer needs has no selling point in the quality planning table, there can be a judgment of equal to the competition.
 - 4) In some cases, it can be determined that the current product is exceeding the competition, which could create a cost penalty. In such a case, the judgment might be to set the target at worse than the competition.

EXAMPLE 4 [Table 10](#) shows that the QFD team judges that achieving the 60 % of display in the morning can make our product much better than the competition. Offering six varieties of bagels also makes the company's product much better than the competition.

- e) Judgment relative to technical challenge can be useful in capturing the QFD team's opinion about the difficulty in achieving the target value with the current or available technology in time for any market launch commitment.
- 1) If the current or available technology can be sufficiently improved to meet the target value, then there is no technical challenge.

- 2) If the current or available technology cannot be sufficiently improved to meet the target value, but there is a reasonable opportunity for innovation or creativity to result in a technology in time for any market launch commitment, then there is a minor technical challenge.
- 3) If the current or available technology cannot be sufficiently improved to meet the target value, and there is not a reasonable opportunity for innovation or creativity to result in a technology in time for any market launch commitment, then there is a major technical challenge that can require research and development efforts, trade-offs, patent licensing, or other paths to a solution.

EXAMPLE 5 [Table 10](#) shows that the QFD team believes there is no technical challenge to arranging the display case to hold 60 % breakfast items. Increasing the number of bagel varieties presents a minor technical challenge in terms of inventory management.

- f) Judgment relative to technical advantage can be useful in capturing the QFD team's opinion about technical leverage for other product lines or future products.
 - 1) If meeting the target value in this product has little or no potential to be leveraged for other current or future products, then there is no technical advantage.
 - 2) If meeting the target value in this product has real potential to be leveraged for other current or future products, then there is a minor technical advantage.
 - 3) If meeting the target value in this product has great potential to be leveraged for other current or future products, then there is a major technical advantage.

EXAMPLE 6 [Table 10](#) shows that the QFD team judges there can be a minor technical advantage to making the display case time-of-day flexible. This then allows more lunch and dinner products to be offered at the appropriate time, which is a major technical advantage.

- g) Results from a Kano model survey can be displayed in the design planning table.

EXAMPLE 7 [Table 10](#) shows Kano survey results confirming that increasing visibility of options to 60 % of the display case in the morning can be satisfying to customers but that keeping it at 10 % is not dissatisfying, which is an exciting quality category. Kano survey results confirm that increasing number of bagel varieties to six can be very satisfying to customers but that keeping it at two varieties is not dissatisfying.

10.3.4.4 Traditional and new Kano model

10.3.4.4.1 General

The Kano model is a survey method that seeks to understand the relationship between physical fulfillment (or not) of a product function or feature and customer satisfaction.^[26] The new Kano model extends the binary survey question to a series of performance levels.^[47] Since a functional requirement as defined in ISO 16355-1:2015, 3.4 is a product characteristic or capability, the traditional Kano question addresses capabilities and the New Kano question addresses characteristics.

10.3.4.4.2 Traditional Kano survey questions

For each product capability or feature, an inversely-paired set of questions is asked.

EXAMPLE For the airport breakfast kiosk, these questions were surveyed.

- a) If the bagel can be toasted, are you satisfied, neutral, or dissatisfied? (Largest response was neutral.)
- b) If the bagel cannot be toasted, are you satisfied, neutral, or dissatisfied? (Largest response was dissatisfied.)

As shown in [Table 11](#), a response of neutral if fulfilled and dissatisfied if unfulfilled, it is interpreted as "expected quality."

10.3.4.4.3 New Kano survey questions

For each product characteristic, questions at various specific performance levels are asked.

EXAMPLE For the airport breakfast kiosk, these questions were surveyed. The results are entered into the design planning table. It was determined that offering four standard varieties plus two seasonally changing varieties would achieve good choice without the risk of too many choices causing a queue to form.

- a) If two bagel varieties are offered, are you very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied? (Largest response was neutral.)
- b) If four bagel varieties are offered, are you very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied? (Largest response was satisfied.)
- c) If six bagel varieties are offered, are you very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied? (Largest response was very satisfied.)
- d) If eight bagel varieties are offered, are you very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied? (Largest response was very satisfied.)
- e) If seasonal bagel varieties are offered, are you very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied? (Largest response was extremely satisfied.)

NOTE 1 At least five performance levels can be queried to establish a very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied response.

NOTE 2 Customers knowledgeable about the product tend to respond accurately. Fielding respondents can focus on the target customers identified in ISO 16355-2. Number of respondents can reflect sample size calculations explained in ISO 16355-4.

NOTE 3 Queried functional requirements can be limited to 20 to avoid survey fatigue.

10.3.4.4.4 Interpreting the traditional and new Kano survey responses

Depending on the question and response, the following interpretations can be made, as shown in [Table 11](#):

- Exciting (Kano originally termed Attractive) — an exciting product function or feature which gives satisfaction when fulfilled, but is not dissatisfying when unfulfilled;
- Desired (One-dimensional) — a desired product function or feature which results in satisfaction when fulfilled, and dissatisfaction when unfulfilled;
- Expected (Must-be) — a product function or feature which is taken for granted when fulfilled and thus not responded as satisfaction, but results in dissatisfaction when not fulfilled;
- Indifferent — a “don’t care” product function or feature which results in neither satisfaction nor dissatisfaction, regardless of being fulfilled or unfulfilled;
- Reverse — an undesired product function or feature which results in dissatisfaction when fulfilled and satisfaction when unfulfilled;
- Skeptical — an illogical response where the paired responses are both dissatisfied or satisfied, suggesting the question was poorly constructed.

Table 11 — Traditional Kano survey response interpretations

Quality Characteristic Fulfillment	Physically Fulfilled			
Physically Unfulfilled	Feeling of Satisfaction	Dissatisfied	Neutral	Satisfied
	Dissatisfied	Skeptical	Expected	Desired
	Neutral	Reverse	Indifferent	Exciting
	Satisfied	Reverse	Reverse	Skeptical

10.3.4.4.5 Graphing the traditional Kano model

Each function or feature can be graphed, as shown in [Figure 7](#). Since the traditional Kano survey asks only binary questions, it yields only two data points, sufficient to graph only a line. This example is from the airport breakfast kiosk.

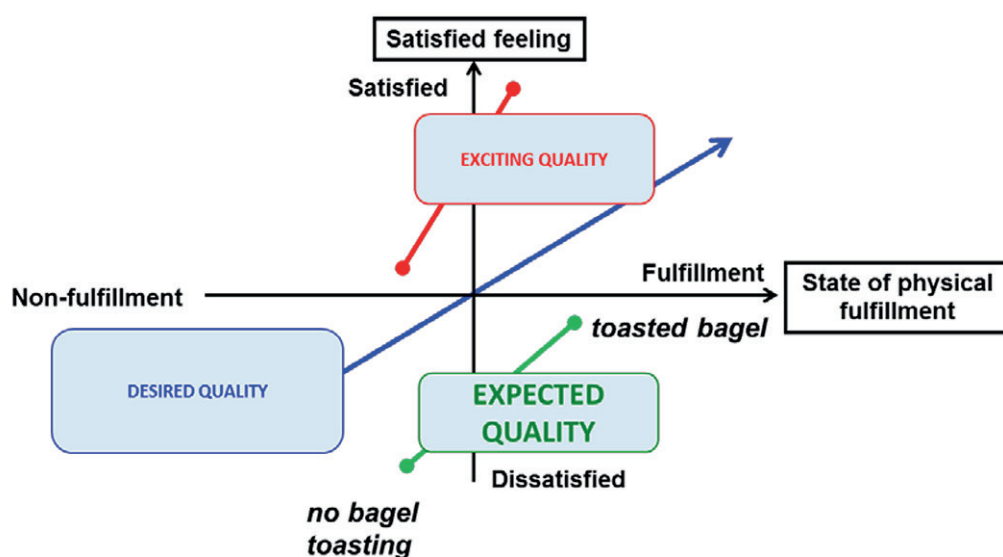


Figure 7 — Traditional Kano model graph of exciting quality and expected quality

10.3.4.4.6 Graphing the new Kano model

With three or more data points from the new Kano survey questions of performance levels, curves can be graphed to interpolate additional values as shown in [Figure 8](#). This example is from the airport breakfast kiosk.



Figure 8 — New Kano model graph of exciting quality and expected quality

10.3.4.4.7 Using Kano survey results in the design planning table

If the functional requirement is a capability, it can be entered as the target value in the design planning table along with the appropriate Kano survey result. If the new Kano survey result is a characteristic, the level the QFD team determines it wishes to achieve can be entered as the target value in the design planning table along with the appropriate Kano survey result.

EXAMPLE The results of the binary Kano survey questions about bagel toasting are entered into the Kano survey section of the quality planning table as “expected.” This can be used to validate or adjust the target value above. The results of the performance levels in the new Kano survey questions about # varieties are entered into the Kano survey section of the quality planning table as “exciting.” This can be used to validate or adjust the target value above.

NOTE Look for a correspondence between the predicated Kano category for the customer needs in the quality planning table and the actual Kano survey results for functional requirements that are strongly related to the customer needs.

10.3.4.4.8 Other uses of Kano model

10.3.4.4.8.1 Adjustments for market segments based on Kano model

Survey responses are market specific. Key market or customer segments identified earlier in the QFD process can be surveyed first, since different segments can yield different response categories. For example, remote control starting that would be exciting by an entry level vehicle consumer might be considered expected by a luxury level vehicle consumer. Market and customer segmentation concerns are explained as follows:

- identifying and prioritizing key market segments are explained in ISO 16355-2;
- survey creation and fielding methods are explained in ISO 16355-3;
- survey sample size calculations are explained in ISO 16355-4;
- sorting survey responses by market demographics can reveal hidden segments.

EXAMPLE An automotive manufacturer discovered in a new Kano study of stopping distance that aggregating all responses masked the variation between male and female drivers of an entry level vehicle. When these were broken out by sex, they were able to see product variations that satisfied male and female drivers which could then be reflected in different performance packages available to the consumer.^[47] This is graphed in Figure 9.

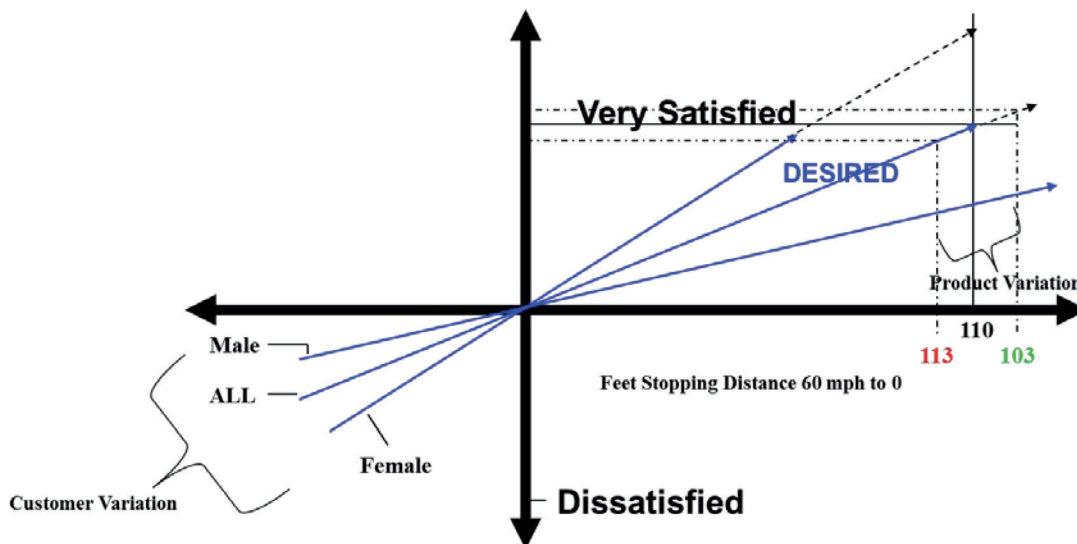


Figure 9 — New Kano model graph of stopping distance targets, by sex

10.3.4.4.8.2 Adjustments for competitive products and time based on Kano model

When an exciting product feature or performance level is introduced, competitors seek to copy it. Eventually, all products can have this feature or performance level, and it can become expected. For example, automatic syncing a personal device with an automobile infotainment system was once found only on luxury vehicles, but is now standard on almost all vehicles. The effects of competition and time on the Kano model are shown in Figure 10.^[47]

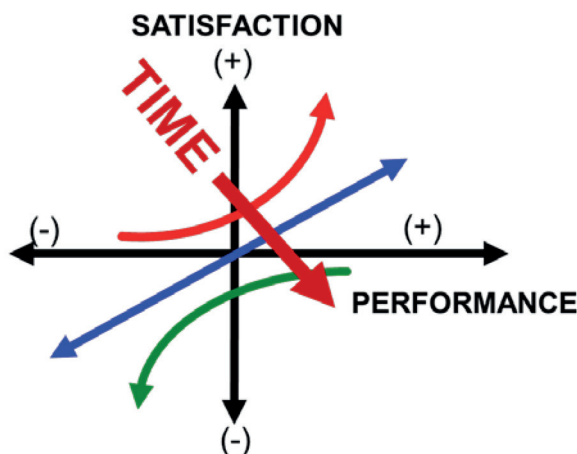


Figure 10 — New Kano model graph of influence over time

10.3.4.5 Weighted design planning table

Weighting of the design planning table allows for adjusting the impact of these other factors on the functional requirement priorities. Weight adjustments help the QFD team allocate constraints

such as human resources, schedule, and budget with greater precision. According to the project goals determined earlier in the QFD project, it can be that the customer need-prioritized functional requirements, competitive benchmark, technical challenge, and Kano survey results are not equally important factors. For example, if the company is trying to grow the market, then customer need-prioritized functional requirements can be the most important factor. If a competitor has a preferred product, then competitive benchmark can be the most important factor. If there are no preferred solutions, then technical challenge can be the most important factor. If the company is considering a new technology, then the Kano survey can be the most important factor. Modern QFD allows weighting of these factors as shown in [Table 16](#).

NOTE 1 The weighted design planning table adds absolute weights to the unweighted design planning table in [10.3.4.3](#) which contains verbal information only.

EXAMPLE 1 In this example from the airport breakfast kiosk, an AHP paired comparison was done by the QFD team on these four factors yielding these factor priorities: customer-prioritized functional requirement priorities: 57,3 %, competitive benchmark: 10,6 %, technical challenge: 5,9 %, and Kano survey: 26,2 %, as shown in [Table 12](#). The QFD team did not consider the technical advantage information found in [Table 9](#) significant enough to include in this fine-tuning.

Table 12 — AHP weighting of design planning table adjustment factors

factors	Customer	Competition	Technical Challenge	Kano	normalized columns				sum	row avg
Customer	1	5	8	3	0,603	0,526	0,500	0,662	2,291	0,573
Competition	1/5	1	2	1/3	0,121	0,105	0,125	0,074	0,424	0,106
Technical Challenge	1/8	1/2	1	1/5	0,075	0,053	0,063	0,044	0,235	0,059
Kano	1/3	3	5	1	0,201	0,316	0,313	0,221	1,050	0,262
	1,66	9,50	16,00	4,53	1,000	1,000	1,000	1,000	4,000	1,000
Inconsistency Ratio										0,02

EXAMPLE 2 The customer need-prioritized functional requirements weights are already normalized and sum to 100,0 % as shown in [Table 16](#). In AHP, these are called local priorities. To adjust these weights, each local priority is multiplied by the factor weight for customer of 0,573. Thus, 30,1 % $\times$ 57,3 % = 17,2 %, rounded to three decimal places. These are called global priorities. This is repeated for all columns. As a check, the global priorities sum to the factor weight.

EXAMPLE 3 In this example from the airport breakfast kiosk, an AHP paired comparison was done by the QFD team on the competitive levels of much better, better, equal to, or worse than the competition, as shown in [Table 13](#). When the judgment is much better, a value of 55,8 % is entered into the table. This is repeated for all columns. The values are then normalized by summing them and dividing each by the sum. These values are entered into [Table 16](#) as a local priority. To adjust these weights, each local priority is multiplied by the factor weight for competition of 0,106. Thus for visibility of options, 37,2 % $\times$ 10,6 % = 3,9 %, rounded to three decimal places.

Table 13 — AHP weighting of levels of competition

Competition	Much Better	Better	Equal	Worse	normalized columns				sum	row avg
Much Better	1	3	5	7	0,597	0,662	0,536	0,438	2,232	0,558
Better	1/3	1	3	5	0,199	0,221	0,321	0,313	1,053	0,263
Equal	1/5	1/3	1	3	0,119	0,074	0,107	0,188	0,487	0,122
Worse	1/7	1/5	1/3	1	0,085	0,044	0,036	0,063	0,228	0,057
	1,68	4,53	9,33	16,00	1,000	1,000	1,000	1,000	4,000	1,000
Inconsistency Ratio										0,04

EXAMPLE 4 In this example from the airport breakfast kiosk, an AHP paired comparison was done by the QFD team on the technical challenge levels of major minor, or none, as shown in Table 14. When the judgment is none, a value of 10,6 % is entered into the table. This is repeated for all columns. The values are then normalized by summing them and dividing each by the sum. These values are entered into Table 16 as a local priority. To adjust these weights, each local priority is multiplied by the factor weight for technical challenge of 0,059. Thus for visibility of options, $8,4 \% \times 5,9 \% = 0,5 \%$, rounded to three decimal places.

NOTE 2 In this example, a major technical challenge is scored very strongly, which adds weight for the purpose of directing development effort to this challenge. In projects where speed-to-market, insufficient resources, or a small budget constrains the team, they can score a major technical challenge inversely, which lowers the weight for the purpose of directing development effort away from this challenge.

Table 14 — AHP weighting of levels of technical challenge

Technical Challenge	Major	Minor	None	normalized columns			sum	row avg
Major	1	3	5	0,652	0,692	0,556	1,900	0,633
Minor	1/3	1	3	0,217	0,231	0,333	0,781	0,260
None	1/5	1/3	1	0,130	0,077	0,111	0,318	0,106
	1,53	4,33	9,00	1,000	1,000	1,000	3,000	1,000
Inconsistency Ratio								0,03

EXAMPLE 5 In this example from the airport breakfast kiosk, an AHP paired comparison was done by the QFD team on the Kano model categories of exciting, desired, expected, indifferent, and reverse, as shown in Table 15. When the survey indicates the functional requirement target level would be exciting, a value of 50,3 % is entered into the table. This is repeated for all columns. The values are then normalized by summing them and dividing each by the sum. These values are entered into Table 16 as a local priority. To adjust these weights, each local priority is multiplied by the factor weight for Kano of 0,262. Thus for visibility of options, $39,5 \% \times 26,2 \% = 10,4 \%$, rounded to three decimal places.

NOTE 3 The AHP scoring of the Kano categories can be changed according the project and customers. In very new technology projects, for example, just meeting expected quality can be judged by the team to be more important than exciting quality.

EXAMPLE 6 The global priorities are then summed for each functional requirement to calculate the adjusted priority. For visibility of options, $17,3 \% + 3,9 \% + 0,5 \% + 10,4 \% = 32,0 \%$ rounded to three decimal places. Optionally, rank order can also be displayed, as shown at the bottom of Table 16.