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

Part 7: Guidelines for developing digitalized products and services — General principles and perspectives of the QFD method

Application des méthodes statistiques et des méthodes liées aux nouvelles technologies et de développement de produit — Partie 7: Ligne directrices pour le développement de produits et services numérisés — Principes généraux et perspectives de la méthode de déploiement de la fonction qualité (QFD)

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Foreword

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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).

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For an explanation of the voluntary nature of standards, 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 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.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html..

Introduction

Quality function deployment (QFD) is a method to assure 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 are 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.

The current ISO 16355 series describes methods and tools of QFD independent of industry because the principles of applying statistical methods for product and technology development are similar for all types of products. However, when applying the standard for the development of fully or partially digitized products, specific characteristics of digital goods in product development (such as measurability, immateriality, etc.) should be taken into account. Digital goods such as software are specific in economies of scale and network effects and thus require specific strategies and concepts for design, development and marketing. Due to the progress of digitalization in almost any market, the observed phenomena and measures gain relevance and importance in business and academia. Hence the emerging convergences in industries, suppliers, businesses and products cause a game change in markets for digital or digitized goods.

Therefore, this document describes guidelines for developing digitalized products and services. It aims at adapting the (QFD) process, its purpose, users, and tools as they are described in the ISO 16355 series with respect to the specific characteristics of digitalized products and services. All companies affected by the digitization of their products and services are intended users of this document.

The methods and tools shown and described represent decades of improvements to QFD; the list is neither exhaustive nor exclusive. Users should consider the applicable methods and tools as suggestions, not requirements. As the other parts of the ISO 16355 series, 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 7: Guidelines for developing digitalized products and services — General principles and perspectives of the QFD method

1 Scope

The current ISO 16355 series is written intentionally independent of industry because the principles of applying statistical methods for product and technology development are similar for all types of products. However, when applying the standard for the development of fully or partially digitized products in practice, specific characteristics of digital goods in product development (such as measurability, immateriality, economies of scale effects, etc.) are taken into account.

This document gives guidelines for adapting the quality function deployment (QFD) process, its purpose, users, and tools as they are described in the ISO 16355 series that consider these specific characteristics for developing digitalized products and services. Table 1 illustrates the scope of this document by stating examples of the types of products the standard focuses on.

Users of this document include all organization functions necessary to assure 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 the 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, *Application of statistical and related methods to new technology and product development process — Part 1: General principles and perspectives of quality function deployment (QFD)*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
digitalized products and services
works that incorporate components consisting of operable objects from digital information and communication technology

Note 1 to entry: In this document, the terms digital, digitized and digitalized are used synonymously. A digitalized good is an intangible software enabled product or service that can be sold and distributed repeatedly online without the need to replenish inventory. Digitalization may cause services to have a stronger product character.

Note 2 to entry: In this document, software product development means the development of digitalized products and software parts of software-intensive products, i.e. systems or services.

Note 3 to entry: Software parts of software-intensive systems that are not marketed and priced as separate entities are called embedded software.

Note 4 to entry: Software-intensive systems can be products from all industries such as automobiles, airplanes, smartphones etc.

Note 5 to entry: Software-intensive services, often delivered as cloud services, can also be products from all industries like financial, insurance, gaming, social software, or human services based on software support.

Note 6 to entry: This document will generally use the term “software products” instead of explicitly referring to software-intensive products.

Note 7 to entry: When other parts of ISO 16355 series or ISO 9000 series standards are referenced in this document, note they may not differentiate explicitly between products and services.

3.2
quality function deployment
QFD
managing of all organizational functions and activities to assure product quality

Note 1 to entry: The organization is responsible for product quality and strives for it via defining, testing, building, commercializing, and supporting the product.

Note 2 to entry: Literal definition is that the “quality function” is “deployed” to all other business functions and departments who play a role in assuring quality and customer satisfaction.

Note 3 to entry: In most cases, the interests of an organization are commercial, but there are exceptions, as is sometimes seen in open source-based products or in the public sector.

3.3
voice of customer
VOC
communications from the customer, user, and others

Note 1 to entry: The communications from the customer may be verbal, written, video, audio, animation, or other form and may be descriptive, behavioural, or ethnographic.

Note 2 to entry: Customer is defined in ISO 9000:2015, 3.2.4.

Note 3 to entry: For digitalized products and services, the voice may not come from the customer itself but from data or other artefacts relevant for quality.

Note 4 to entry: Customers may be not only human but also digitalized actors (digital agents).

3.4
customer need
potential benefit to a customer

Note 1 to entry: The benefit to a customer from having their problem solved, their opportunity enabled, their image (self or to others) enhanced, or being advanced to a more desirable state.

Note 2 to entry: The benefit is positively stated.

Note 3 to entry: The benefit describes a single issue.

Note 4 to entry: The benefit is independent of the product or service performance, functional requirements, non-functional requirements, functions, features, or enabling technologies.

Note 5 to entry: A need may be explicit or latent.

Note 6 to entry: Customer is defined in ISO 9000:2015, 3.2.4.

Note 7 to entry: Requirements engineering for digitalized products and services defines customer needs differently than ISO 16355-1. Requirements engineering in focusing on product requirements may not deal with customer needs explicitly. Customer needs may be latent according to ISO 16355-1 which does not match the definition of requirements in ISO 9000 where needs must be stated explicitly. If the input to voice of customer is considered as customer needs in requirements engineering, the voice analysis yields stated requirements which may be interpreted as customer requirements as the complement to product requirements. Hence in requirements engineering the term customer requirements may be used synonymously to customer needs[2].

Note 8 to entry: The term demanded quality is also used in software QFD projects.

3.5
functional requirement
characteristic that a product or service is specified to possess

Note 1 to entry: The characteristic may be an inherent performance of the product or service or an action that the product or service may be able to accomplish. The manner in which the product accomplishes the action does not include specific mechanisms or internal procedures as part of the functional requirement.

Note 2 to entry: Product is defined in ISO 9000:2015, 3.7.6.

Note 3 to entry: Service is defined in ISO 9000:2015, 3.7.7.

Note 4 to entry: Common methods for the specification of requirements for digital products and services differentiate between functional and non-functional requirements, whereas functional requirements address actions a product may accomplish and non-functional requirements the inherent performance of a product. The terms quality requirement, and quality characteristics are also used in software QFD projects.

3.6
voice of stakeholder
VOS
communications from stakeholders

Note 1 to entry: Communications from stakeholders may be verbal, written, video, audio, animation, or other form and may be descriptive, behavioural, or ethnographic.

Note 2 to entry: Stakeholder is defined in ISO 9000:2015, 3.2.3.

Note 3 to entry: Stakeholders may be not only human but also digitalized decision-makers (digital agents).

Note 4 to entry: For digital goods, the stakeholder “solution developer” is particularly important because the product is often created incrementally in close cooperation with the customer.

3.7
customer gemba
location where true customer information is found

Note 1 to entry: Gemba is a Japanese word meaning the place where the truth is discovered. In Six Sigma, this usually refers to the shop floor where internal activities take place. In QFD for new product development, the new product does not exist yet, so the gemba changes to where the customer's activities or encounters take place.

Note 2 to entry: The gemba may be not limited to physical location. For digitalized products, digitalized spaces may exist where human actors directly may not explore (for example, cyberspace).

Note 3 to entry: Gemba visits help discover unknown or latent customer needs and requirements.

3.8
hoshin kanri
method for management and deployment of strategic organizational policy

Note 1 to entry: English translations of the Japanese include policy management, policy deployment, management by policy, and strategy deployment.

4 Basic concepts of developing digitalized products and services

4.1 General

This standard describes guidelines for adapting the methods described in ISO 16355 series standards that consider the specific characteristics for developing digitalized products and services. See Table 1.

Table 1 — Digitalized products and services in scope of this document

	Degree of digitization		
Degree of servizitation	Physical	Digitalized(hybrid)	Digital
Product	Watch with mechanical movement	Smart watch	Watch App on smartphone or notebook
Hybrid product/ Hybrid service	Phone with contract	Intermodal mobility services	Onlince booking (with chipTAN)
Service	Car repair	Car navigation system (update performed by car garage)	Automatic download via web services

not focus of ISO 16355-7	focus of ISO 16355-7

4.2 Characteristics of digitalized products and services and their development

4.2.1 Specific characteristics of digitalized products and services

Digital products and services have specific characteristics that influence the applications of statistical and related methods to new technology and the product development process.

a) digital "voices" from customers and stakeholders;

b) availability of digital data from product usage;

c) easier product changes during development;

d) easier product changes after delivery;

e) cloud based product functions;

f) high rate of change due to requirements uncertainty and technology dynamics.

4.2.2 Effects of specific characteristics of digitalized products and services on the development process

These characteristics affect the development process of digitalized products and services.

a) agile development as widely used paradigm for developing software;

NOTE There is no one common agile development model, Typical methods in practice are scrum, extreme programming (XP) or kanban. All models refer to certain core concepts going back to agile principles and values of the Agile Manifesto[3].

b) iterative development process for digital functions;

c) incremental development process for digital functions;

d) non-deterministic development and production process;

e) negligible manufacturing cost;

f) value co-creation through platform ecosystems.

4.2.3 Requirements change management in the development of digitalized products and services

Requirements change in every case and thus ways have to be found to deal efficiently with these changes. Agility stands here for the ability to handle these changes efficiently, aiming at a kind of balance between structuring and flexibility. According to ISO/IEC/IEEE 26515[4], it is "based on iterative development, frequent inspection and adaptation, and incremental deliveries, in which requirements and solutions evolve through collaboration in cross-functional teams and through continuous stakeholder feedback." It represents a countermovement to traditional, sequential development models in response to the increasing dynamics of change in requirements

4.3 Design guidelines for developing digitalized products and services

4.3.1 General

Based on the characteristics and the effects on the development process the following design guidelines form the framework for developing digitalized products and services with QFD[5][6].

4.3.2 Iterative and incremental development for digital functions

Development is in short time frames in which a set of features is developed, leading to a working product that can be demonstrated to stakeholders in order to incorporate immediate and intensive feedback to early product versions which contributes to the constant growth of the digital good and its functions.

4.3.3 Close collaboration, cooperation, and co-creation of customers' and developers' side

While requirements engineers and product managers increasingly use data analytics methods, experience shows that it is important to spend a significant amount of time in direct contact with customers to gain a deep understanding of the context in which the product is being used and of the customer needs.

Regular participation and engagement helps to keep abreast of issues and trends facing existing customers. Direct contact with customers by personal, face-to-face communication not only supports an analytical understanding of their problems but may also create empathy.

Collecting relevant customer data is only the first step to create insights. For digitalized products and services, the voice may not come from the customer itself but from data or other artefacts relevant for quality. Customers may be not only human but also digitalized actors (digital agents). Requirements engineers and product managers need to feed this data into discussions with stakeholders and use it for requirements analysis with QFD, as well as for business modelling.

Digitized products are often not monolithic products but the result of cooperation in platform ecosystems. An ecosystem is a set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled[7]. For developing digitized products and services, this means not only having to understand the voice of the customer, but also to include the voices of additional complementary actors[8].

4.3.4 Focus on essential activities and tasks

Not only is the focus on the highest priority customer needs and product requirements but also on minimizing non-purposive work efforts within the development process. There should be constant reflections at regular intervals within the development team to become even more efficient.

4.3.5 Consider all aspects of business value

While the focus in QFD as well as in agile development is on satisfying the customer through early and continuous delivery of valuable software, all aspects of business value may be taken into account. This means, for example, not only high-rated functions but also quality requirements and design constraints. In general, the developers are open-minded towards all (even late) changes when delivering higher value.

4.3.6 Sustainable and comprehensible procedure

Apply techniques and methods with comprehensible and reproducible sequence of activities. Such techniques and methods produce trustworthy results that are not regularly questioned or doubted by the involved stakeholders. Authentic and credible procedures and results which lead to increasing confidence and trust concerning job performance are important to deliver.

4.3.7 Foster commitment and motivation

Sustained motivation maintained so that work proceeds. Techniques and methods that are fun to use help the team stay motivated to apply them in the long term. Building development projects around these motivated individuals and giving them the support they need establishes a common understanding and commitment between all stakeholders of the product to be developed.

4.3.8 Use digital data analytics

By analysing the performance statistics or usage data, the development team experiments with different implementations of design and product concepts to focus on innovation and optimization despite uncertainty.

Data analytics methods are used to monitor online reports of market research agencies, blogs, and trade press for customer information, and data analytics software retrieves information about customer behaviour throughout the internet.

Data can also come from the (potential) user side covering how they behave in certain situations, or how much time they spend on which tasks. Data gathering methods may include both direct contact and analytics include customer observation, A/B testing, launching a beta version, and producing a minimum viable product (MVP) or a minimum merchandisable product (MMP) for evaluation.

NOTE A/B testing is randomized testing of two or more versions are shown to different market segments to assess impact and business metrics.

5 Basic concepts of QFD

5.1 Theory of QFD

ISO 16355-1:2021, 4.1 defines quality function deployment (QFD) as an "approach for ensuring quality throughout, but not necessarily, at each stage of the product development process, starting with the initial product concept. As a quality method, the aim is to assure that decisions regarding product development have a defined and repeatable process, are based on factual information, have definable and measureable targets, involve all relevant business departments, and focus first and best efforts where they matter most to customers. QFD should begin upstream in the product development process in order to assure that decisions are made in this way, as downstream rework can be costly in terms of money and delays."