QFD for Services: the Service Matrix of Matrices

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1 Motivation

QFD has been employed in the service industry for over two decades (cf. [21]). However, looking at scientific publications, one is lead to assume that application of QFD for product development is far more common than for service development (cf. topics at international QFD conferences, e. g. [12], [13]). But it seems that current challenges facing service providers, such as a high innovation rate, high customer demands on quality, increasing customer orientation and the demand for full services (cf. e. g. [31], p. 311 et sqq.), are directly related to some core competencies of QFD (cf. e. g. [10], p. 8 et sqq.)

Among service providers, the need for a methodical foundation is also felt. In an empirical study among 282 German enterprises, 81% of the interviewed organization representatives indicated that systematic development of services was expected to increase in their organization (cf. [8]). Most needed for this, according to the survey, were suitable methods and procedures (72%).

A number of approaches for service development have been developed and tested. These approaches focus on customer orientation and customer integration (e. g. CurLy, cf. [27], p. 168 et sqq.). A lot of attention has been paid to methodically backing those models (e. g., process models used in the CoRSE project “From customer to service”, cf. [23], p. 87). In this context, QFD is also mentioned several times as an option for supporting service development, but no example of its application is given.

The aim of this paper is to give an overview of how to employ QFD for service development. We’ll present an approach for methodically backed Service Engineering that is based upon King’s “Matrix of Matrices” approach (cf. [16]). We then show the results of a case study employing this Service QFD variant. Finally, the approach will be reflected critically.

2 Methodical support for service engineering using QFD

Service Engineering is the branch of business administration that deals with systematic development and design of services by using appropriate models, methods and tools used in engineering sciences (cf. [8] or [31], p. 317). The aim is to systematically develop new services and to improve existing ones. In doing this, an analysis is carried out of what needs to be developed or improved, and how this can be done. “How” refers to the individual steps to be taken which in combination make up the process, as well as to the way how these steps should be carried out.

Service Engineering is based on the assumption that services can be developed just like products. The areas applicable to both product and service developments include process models, methodical construction, and product and process modelling as well as modularization and component building (cf. [22], p. 13).

On the one hand, QFD has been suggested to be employed in the design phase of service development. Here, QFD can support customer participation in describing a new service (see [23], p. 87). This opportunity arises because the method is focused on customer orientation as well as it is focused on working in an interdisciplinary team, both being basic elements of QFD.

On the other hand, QFD has been used in combination with SERVQUAL and with Kano’s model as part of an integrated employment of methods. In the first case, it was used for analyzing customer satisfaction with
existing characteristics of the service. Combined with Kano’s model, QFD was used to deduct proposals for action based on the customers’ evaluation of the existence or non-existence of service attributes (cf. [29], based on [23], p. 90). This serves to underline QFD’s capability of not only supporting further development of existing services but also of developing innovations (cf. e. g. [10], p. 129). It also enables a prioritization of deducted proposals for action (cf. [10], p. 13). Innovation as the aim of entrepreneurial efforts is considered the only promising strategy to reach sustainable success (cf. [30], p. 5).

The aim of employing QFD to the development of services in the context of this paper and especially regarding the case study described in section 3.4 is a more extensive application of the method. Service QFD, as presented here, can already be employed in requirements engineering, not only in the design phase. Thus, Service QFD supports the phases requirements engineering, planning, design / conception and realization of service development. This early application of QFD – early in comparison to existing experience with QFD in service engineering – is intended to help reach higher service quality, lower costs and reduced time-to-market (cf. [2], p. 27 et seq.).

3 Service QFD

Service QFD is a variant of QFD which has been tailored to employment in service development. In contrast to classic QFD for product development, the special characteristics of services have to be taken into account when applying QFD to service development. So in section 3.1 we identify the effects that service characteristics have on QFD applications. Based on existing approaches of QFD for services outlined in section 3.2, we deduce the service matrix of matrices in section 3.3. Finally, in section 3.4, we describe a case study for identifying marketing measures for a university program.

3.1 Characteristics of services

Characteristic features of services, which distinguish them from material goods, include the following (cf. [28], p. 8):

- Services are insubstantial and intangible.
- Provision of services implies immediate contact between suppliers and demanding parties.
- Provision of services demands a higher degree of individuality.
- Production and consumption of services occur simultaneously.
- Services cannot be stored.
- Services are tied to one location.

Insubstantiality and intangibility are some of the reasons why services sometimes are difficult to explain, specify and measure (cf. [6], p. 190). These two characteristics also lead to the customer being unable to test the service before buying it. The risk incurred when buying a service is also more noticeable compared to buying a product (cf. [28], p. 8 et seq.). It requires further information about expected quality. This has to be taken into account when generating or deducting solutions in the form of product features. These features should possibly give the customers some idea about those service characteristics that are meant to fulfill the customers’ requirements at an early stage in the development process. As an example, when offering an
insurance policy then the process to follow in the case of a covered event should be described in detail, and estimates concerning required time and cost for the customer for handing in the claim should be given.

Customers, however, can only evaluate a service’s quality after making use of it. The quality felt is the decisive factor of the customer’s satisfaction with the service, whether he or she will use this service again and whether they will recommend it to others. In order to find starting points regarding improvement of the perceived quality, it has to be measured. Independently of the service type, the evaluation criteria used by customers can be assigned to one of ten key dimensions (cf. [24], cited in [28], p. 12):

1. Reliability
2. Reaction rate
3. Competence
4. Ease of contact
5. Politeness
6. Communication: willingness and ability to inform
7. Credibility
8. Safety
9. Understanding
10. Material environment

For employing QFD in Service Engineering this means that these criteria have to be considered as quality elements (in the House of Quality).

Provision of services requires immediate contact between suppliers and demanding parties and usually a higher degree of individuality. These two characteristics can be summarized as the necessity for integration of an external factor. This implies that the service customer introduces himself or herself or an object into the service process (see e. g. [22], p. 15). That means that in many cases the customer is co-producer of the service. Even if the customers are not participating actively, they have great influence on provision of the service. Thus, each service rendered is different depending on the person receiving the service. Satisfying the requirements of several customers with very different expectations by offering just one service is usually only possible by accepting reduced levels of satisfaction for some of the customers. Thus, identifying several customer groups that can be clearly separated according to their requirements becomes very important. Several variants of a service should be offered in order to fulfil the requirements of different customer groups. In terms of QFD, this means additional matrices that set customer requirements against customer groups. For each group, variants of the service need to be planned and developed. These variants are due to the individuality of service providing and they manifest themselves e. g. in different forms of provision. As an example, the service “providing photographs on paper” should allow for different ways of delivering the input material such as undeveloped film, digital files or transparencies, delivered either in person, by mail or by e-mail.

The inability to store services results directly from the fact that production and consumption of services take place simultaneously. Consequently, the service cannot be owned or transported (cf. [6], p. 191). However, this does not hold for all services since in some cases a service’s results can indeed be stored, or saved and then used some time after acquisition, e. g. in the case of summaries of consulting results (see [4], p. 16).
For the planning and conception of a service this means that there are no “products” in store which might become obsolete or lose value in the case of updating the service concept so that they can only be sold at a reduced price. However, such an update as well as training employees who are involved in the service implies costs. Therefore, not every service is more advanced than the last one provided. This means for applying QFD and in order to focus the service process on customer needs that not only the result of each step but also how each step is carried out has to be focused on the customers’ requirements. In process deployment, this becomes apparent in a matrix setting process steps against quality and product features. As an example, when delivering a consulting service, the result needs to be easily comprehensible for the customer and has to convey competence and credibility, and at the same time each activity such as interviews and document reviews needs to fulfil these criteria, as well.

That services are tied to only one location does not hold for all services, either. With available technologies evolving fast and increased mobility, it is valid for less and less services. When developing services that are indeed bound to one location, specific local conditions (e. g., geographic or cultural) and requirements (e. g., laws and standards) need to be taken into consideration when deriving solutions. For the application of QFD in service development this means that these local conditions need to form part of the requirements.

When further enhancing the service “provision of cash”, for example, local safety regulations, customer habits regarding means of transportation and preferences for different means of payment as well as the customers’ safety demands need to be taken into consideration.

3.2 QFD for Services: Case studies

Numerous examples have been published of how to apply QFD to service development. For example, there are applications in health care [19], education [3] or for re-designing an airline’s first class offering [9]. For application in services, QFD has also been used in combination with other service engineering methods, e. g. with Service Blueprinting in [7]. An overview of Service QFD state-of-the-art is given in [21]. Not included there, however, are specifics of applying QFD in service or a classification of existing approaches. There’s a great variance among QFD applications in service concerning focus and procedures. In order to illustrate this, we’ll briefly present some of these applications.

Akao and Inayoshi use QFD to plan the quality of service of a university library (see Figure 1). In doing this, they distinguish between Quality of Product and Quality of Operations. Quality of Product here refers to the service provided (the “product”) in a narrow sense, and Quality of Operations means quality of the processes of providing the service. Since the customer cannot distinguish between quality of service in a narrow sense and process quality, the argumentation goes, both have to be considered as integrated parts (cf. [3], p. 201, see also section 3.1). Therefore, in the first matrix requirements on service quality are set against process features, i. e. process steps, in order to determine weighted quality requirements. These are then set against “product” features in the second matrix, so that the result is critical requirements on process quality. In the example provided, this comes down to material selection (i. e., books and magazines on the topic researched, cf. [3], p. 204).
Prates and Boan [26] also stress the service providing process and the importance of the requirements on the product that is an integral part of the service. They also use two matrices, but differently: In the first matrix they set customer requirements on product and process against quality features of the product and process, in order to plan the product. In the second matrix, they plan the process by setting process steps against quality features of the product and process (cf. [26], p. 136 et seq.).

In two case studies concerning a hospital and the telecommunications industry (cf. [20]) Mazur et al. use a whole set of matrices which they categorize in different deployments [in the following cf. [21] p. 42-44]:

- Customer Deployment to identify and prioritize the most important customer groups based on the analysis and prioritization of organizational and project aims.
- Voice of Customer Deployment to understand the true customer requirements by analyzing explicit and implicit requirements and the application context.
- Quality Deployment for prioritization of service quality elements based on the weighting of the customer requirements (esp. House of Quality).
- Function Deployment for prioritization of functions the service has to provide with respect to the customer requirements and the quality elements.
- Reliability Deployment to detect possible sources of failures in the customer requirements, quality elements and the service functions.
- New Process Deployment for analyzing new alternatives for performing the functions.
- Cost analysis of all identified items.
- Task Deployment for planning the necessary process steps according to the selected processes and most important functions.

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**Figure 1: Matrix of Operational Functions x Quality Elements for Library Services (cf. [3], p. 201)**

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- Cost analysis of all identified items.
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**Table 1: Assurance Item Deployment Table**

<table>
<thead>
<tr>
<th>Operational Function Deployment Table</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
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</thead>
<tbody>
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<td>Prepare a budget</td>
<td>Level 1</td>
<td>Level 2</td>
<td>Level 3</td>
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<tr>
<td>Draft book purchase list</td>
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<td>Level 2</td>
<td>Level 3</td>
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<tr>
<td>Draft new magazine</td>
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<td>Level 2</td>
<td>Level 3</td>
</tr>
</tbody>
</table>
- Standardization to maintain the gained advantages by means of job descriptions and standardized operating procedures.

They combine all these deployments in a matrix sequence called “Comprehensive Service QFD” ([20], p. 50), based on Akaos Comprehensive QFD (cf. [2]). In the above mentioned case studies they don’t use all of the deployments but a selection of these respectively.

Kaneko shows in a case study how applying QFD for planning and further development of a service, combined with focus on one target group and systematic comparison to competitors, dramatically increased competitiveness and customer satisfaction of a hotel in Tokyo (see [14]). Pawitra, Tan and Xie illustrate systematic comparison to competitors and improvement potentials identified and prioritized based on a customer survey and on comparison to competitors for the travel industry (see [25]). A similar but more comprehensive approach is presented by Fehlmann in [9] concerning repositioning an airline’s first class offerings. Kano’s model of service quality (see [15]) is used for identification and classification of customer requirements, and the improvement activities’ benefits are measured by means of a customer survey and by their economic success. In essence, three matrices are identified: Customer requirements – product quality elements, product quality elements – cabin service, and customer requirements – verification & validation. Cabin service exemplifies one possible service components i.e. process functions. Thus, different matrices can be used in order to set different service components against customer requirements and product quality elements respectively.

Koura, Tomizawa and Fujino employ QFD for a hospital. They use one matrix to set process steps against customer requirements. Based on a competitive analysis and target values identified for improvement, in a second matrix process improvement is planned (see [19]). Eringa and Boer integrate QFD and Service Blueprinting in order to improve a university’s service quality in the Netherlands (cf. [7]). The following matrices are used:

- Customer requirements – customer encounter/technical interfaces in order to calculate the importance of the various existing interfaces and/or interaction points with the customer,
- Customer requirements – new customer encounter/technical interfaces for identifying improved interfaces, and
- New customer encounter/technical interfaces – internal support interfaces responsible for delivery of a service.

These matrices result from linking QFD with Service Blueprinting, which represents the service process as a chain of several steps and focuses on the interfaces and thereby the interaction between customer and organisation.

### 3.3 Service Matrix of Matrices

The approaches presented above are characterized by different employments of QFD in each case. They can be interpreted as proof that there is no standard procedure for applying QFD in service development. Rather, there is a variety of matrices corresponding to the variety of QFD applications. This spectrum of
matrices, however, can be dealt with systematically. The following list of possible elements is derived from the analysis of the case studies in section 3.2:

- customer groups,
- customer requirements,
- product quality elements,
- process quality elements,
- process functions,
- possible failures,
- costs,
- process steps,
- new processes/process improvement,
- customer interfaces,
- new customer interfaces,
- internal support interfaces.

Similar to the Matrix of Matrices developed by King (cf. [16]), combinations of these elements can be displayed in a Service Matrix of Matrices (see Fig. 2).

<table>
<thead>
<tr>
<th>Z</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Customer groups</td>
<td>Product quality elements</td>
<td>Process functions</td>
<td>Process quality elements</td>
<td>Possible failures</td>
</tr>
<tr>
<td>1</td>
<td>Product lines</td>
<td>Customer groups</td>
<td>Customer interfaces</td>
<td>Process steps</td>
<td>Costs</td>
</tr>
<tr>
<td>2</td>
<td>Customer groups</td>
<td>Customer interfaces</td>
<td>Process functions</td>
<td>Process steps</td>
<td>Possible failures</td>
</tr>
<tr>
<td>3</td>
<td>Customer requirements</td>
<td>New customer interfaces</td>
<td>New processes</td>
<td>Process steps</td>
<td>Costs</td>
</tr>
<tr>
<td>4</td>
<td>Internal support</td>
<td>Process quality elements</td>
<td>Process steps</td>
<td>Process steps</td>
<td>Possible failures</td>
</tr>
<tr>
<td>5</td>
<td>New customer</td>
<td>Process steps</td>
<td>Costs</td>
<td>Process steps</td>
<td>New processes</td>
</tr>
</tbody>
</table>

Figure 2: Service Matrix of Matrices
Of course there are not all possible combinations shown in the Matrix of Matrices but those used in the examples of Service QFD applications discussed in section 3.2. Like the Comprehensive Service QFD of Mazur et. al. you can categorize the matrices in several deployments:

- Customer Deployment: Z1-Z3
- Quality Deployment: A1, B2, C2, D2, E2
- Function Deployment: B1, B3, C3, D3, E3
- Process Deployment: C1, B4, C4, D4, E4
- Reliability Deployment: D1-D5
- Cost Deployment: E1-E5, C5
- Interface Deployment: A2-A5
- Process Improvement Deployment: B3-B5, A5

Moreover, the way the service matrix of matrices was derived supports the assumption that it covers in general the possible matrices to apply in a concrete service development project. In other words: the service matrix of matrices is characterized by the necessary flexibility to be adjusted to all sorts of services.

3.4 Case study: Marketing for a university program

In practical application of Service QFD you have the problem of deciding which of the matrices you need. In the following we’ll present an example of how to select matrices from the Service Matrix of Matrices according to the service to be developed or improved.

3.4.1 Introduction and Initial Situation

The example is taken from an innovative area: university program marketing. In line with the marketing definition by the American Marketing Association¹, university program marketing in this article refers to all services and benefits that one or more universities or organizational elements of a university (e.g., departments) offer in order to satisfy individual and organizational aims.

Of all the components of Kotler’s Marketing Mix (cf. [17]), communication policies are of particular importance: “Marketing consists of more than producing a good product, introducing it onto the market and setting an attractive price. If an enterprise wants to be competitive, it needs to direct sales promoting communication to current and potential customers” (see [18], p. 6)

The program under consideration is Bachelor of Science in Information Systems. It’s been offered since the fall semester of 2001 by the universities of Stuttgart and Hohenheim in cooperation. Thus, it is among the first programs at German universities to implement directives of the Bologna Process. Since the program is small, relatively new and the final degree is not well-known, an efficient concept for promoting the program was assumed to be a promising approach to integrate the program into the region’s higher education offerings.

¹ “Marketing is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational objectives.” [1]
3.4.2 Course of the project

QFD was selected in order to plan, control and continuously improve the quality of the complex service “communication policy”. This process was supported by the software tool easyQFD 3.0 which had been developed as part of the program. This tool’s advantage over existing QFD software used for documenting the QFD process is that it also supports communication among those involved in the project. easyQFD is an internet-based application that enables distributed cooperation. All those involved in developing the service can use this platform independent of time and location. Employing easyQFD which supports product development as well as service development, is of great use to partners and experts working together from different locations.

As pointed out in section 3.1 a differentiation of customer groups is essential in Service QFD. So as a first step, customer groups were identified (matrix Z2). The identified customer groups were: people interested in the program, study counsellors, students already enrolled, teaching staff (professors, researchers, teaching assistants, guest lecturers), alumni and business representatives (as potential employers after graduation or for internships, working students or for cooperation on final projects). These groups’ requirements were gathered in interviews with current students and those interested in the program, expert interviews with professors and study counsellors and in a moderated meeting that representatives of all groups participated in. In this meeting, statements of the participants were collected and analyzed together with the interviews’ results.

For analysis and evaluation, customer requirements (“what”) as well as solution features (“how”) were identified from the statements. The results of the meeting which incorporated results from the interviews were 23 customer requirements (e.g., “indicate differences from other universities”) and 54 solution features (e.g., “detailed admission requirements” or “hand-outs”). As a next step, the representatives of the customer groups weighted the requirements separately (matrix Z3). Figure 4 shows the weighted requirements of the customer group “students” after entering the weights using easyQFD. For further use, the weighted average of the weights was calculated that the customer groups had assigned to the requirements.

easyQFD provides some useful functions which help analyzing the data:

- a Pareto diagram that displays requirements sorted by importance,
- a portfolio diagram with the dimensions weight of the requirements and level of satisfaction, which illustrates where improvements are most effective,
- a bar chart listing the importance of the requirements by customer group, that can also be used e.g. for analyzing whether customer groups actually differ.
Figure 3: Weighted requirements (students)

Fig. 4: Bar char listing the weighting of the requirements
Further analysis showed that the possible solution features included in the service matrix of matrices i.e. the product quality elements, process functions, and process quality elements don’t fit the example ideally. They are not detailed enough to consider the variety of the possible solutions for marketing activities. Therefore solution features for this service should be separated into “content” and “measures” (see Figure 5). Looking at the examples “detailed admission requirements” and “hand-outs”, this separation becomes evident. The information “admission requirements” can be conveyed in many different ways such as on a website, on a hand-out, at informative events at high-schools etc. The hand-out is only one measure which can convey different types of content. Thus, in a first matrix customer requirements were set against content. The resulting weighted types of content were then set against measures in a second matrix.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Hand-outs</th>
<th>Web site</th>
<th>Alumni database</th>
<th>Mailing lists</th>
<th>Document database</th>
<th>Media networking</th>
<th>Presentation</th>
<th>Graduation ceremony</th>
<th>Bachelor hotline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Information package for prospective students</td>
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<td>Information package for students</td>
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<tr>
<td>Information package for business representatives</td>
<td>✓</td>
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<td>✓</td>
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</tr>
<tr>
<td>Coordination, structure, service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Community (building)</td>
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<tr>
<td>Reputation and image</td>
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<tr>
<td>Recruiting</td>
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<tr>
<td>Career and education opportunities</td>
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<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Figure 5: Content versus Measures Matrix

In order to assure that the weighted measures reach all customer groups, in a third matrix we ran a cross-check. If the measures didn’t satisfy all groups sufficiently further measures would have to be planned. The idea behind this procedure is that some of the selected measures, e.g. a website or events may not be appropriate for all customer groups. The last matrix then serves to plan the service delivery process, and sets
measures against process steps. The sequence of all matrices adapted in the case study is illustrated in Figure 6:

Due to the weighting in each matrix, a focused course of action is assured, and work on the measures with the highest priority gets done first. Another result is an ordered list of measures which are not carried out immediately – in the case of tight resources or time there can also be a limit (see [11] for this procedure in software development).

4 Critical review

The case study reveals the limits of the service matrix of matrices very clearly. Although it seems to be comprehensive the specific solution characteristics “content” and “measures” are not included. Thus, when employing QFD for service development, the service matrix of matrices can only act as a framework for possible matrices to be built. And of course as a framework it has (like Kings original matrix of matrices) to offer as much reasonable matrices as possible; to leave one out could exactly be the one which is missing in a certain development project. Nevertheless, the service matrix of matrices has proven an appropriate approach for giving an overview of the elements that can be analyzed, weighted and prioritized by means of QFD in service development. These elements can then be used for customer-oriented service development.

And, customer-oriented services, also in the form of product add-ons, will increase in importance with growing globalization and intensity of competition. As the numerous examples show, QFD can be em-
ployed successfully for development of new and enhancement of existing services. To present all possible applications of QFD in Service Engineering would go beyond the scope of this paper. In the case study, for example, competitive analysis, use of matrices for planning trainings, increasing employee satisfaction, but also the use of data determined and refined using QFD for continuous improvement of the service, have not been presented. How virtual teams can be assisted by tools such as easyQFD 3.0 in distributed Service Engineering has not been presented, either.

But the examples also show the great differences between different QFD employments in Service Engineering. The heterogeneous nature of services results in the fact that engineering methods cannot be used without adaptation for any sort of service. Rather, some typology of services appears useful in order to employ methods successfully (cf. in the following [5], p. 279). For service development, a typology has been developed based on empirical data. For distinction, this typology makes use of the attributes range of variants, degree of standardisation, intensity of contact and interconnection to material goods by way of hierarchical cluster analysis (cf. [8], p. 32).

In future, it has to be the aim to develop a method for selecting appropriate matrices for a certain Service QFD application with respect to such a typology of services. Currently, this still requires a lot of experience with QFD. The service matrix of matrices derived in this paper then serve as a starting point (framework) for such a selection. But, as the case study of developing a communication policy for the marketing of a university program reveals, there can always be specific conditions that require specific new elements to be looked at.

5 References


Biographies

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holds a Master’s degree in Economics from the University of Cologne, Germany. From 2000 – 2003 she was working at Infineon Technologies AG in the IT department as application administrator. From 2003 – 2004, at Siemens Financial Services she was test coordinator in a large software implementation project concerning a reporting and financial consolidation system. Since 2004, she has been working as researcher and lecturer at Prof. Dr. Georg Herzwurm’s department at the Universität Stuttgart. She is member of the QFD Institute Deutschland (QFD-ID) and has been working outside the university as consultant in QFD and ERP software selection projects. She has co-authored several publications in the area of Quality Function Deployment, and invented the variant Continuous QFD together with Prof. Herzwurm. Currently she’s working on her PhD thesis developing a model for goal-oriented test effort estimation in software engineering.

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