# Application of QFD within a co-opetition network of public transport organizations

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**Abstract:** Public transport organizations are competitors as well as cooperative partners in providing services to their passengers. In this setting of co-opetition we apply QFD heading for the vision of offering passengers integrated transport services. The paper will present the necessary adaptations and extensions of QFD as well as lessons learned.

**Keywords:** public transport, co-opetition network, case study, Continuous QFD, Software QFD

## 1 Introduction

Part of the efforts to make public transport in Germany more attractive is the development and roll-out of a common standard for electronic ticketing. (((eTicket Germany is the brand of the so called VDV-Core-Application, the technical and organizational standard of electronic fare management in Germany.[1] The standard is supported by the Federal German Ministry of Transport, Building and Urban Development and the VDV (Verband deutscher Verkehrsunternehmen), the Association of German Transport Companies.

Using the eTicket Germany, a passenger will be able to purchase tickets from different public transport organizations and associations using e.g. a smartcard or a mobile-app on a smartphone. The purpose is that customers can travel seamlessly along their own individual chain of travel from their starting location to their final destination using only one media as a ticket. Additionally, passengers will no longer have to handle different ticket machines and to understand the multitude of tickets and associated tariffs offered locally (which vary vastly between transport associations). Beyond that, other so-called inter-/multimodal functions like renting a bike or car-sharing and even services for tourists like paying entrance fees for museums can be integrated.

[1] For an overview of the initiative see http://www.eticket-deutschland.de/ and http://mitglieder.vdv.de/wir_ueber_uns/vdv_projekte/vdv_kernapplikation_efm.html (in german).

While it is generally accepted that eTicket Germany will provide a number of important benefits to passengers and increase the use of public transport, it poses serious challenges to many transport providers. About 90% of all German transport providers are rather small bus companies (often privately owned) with little IT know-how and no dedicated IT department. Additionally, their IT infrastructure is frequently rather outdated, while their budget for IT investments is limited. But implementing eTicket Germany requires significant investment in acceptance infrastructure, user media, IT infrastructure and applications for back-office systems.

This is the general set-up for the research project called "Aprikose" ("**Ap**pliance zur Unterstützung von KMU bei der Erb**ri**ngung **ko**mplexer Mobilitäts-**Se**rvices") funded by the German federal ministry of Education and Research. Aprikose aims primarily at providing small and medium-sized companies a cost-effective and easy way of participating as one service supplier in such an eTicket environment. Of course, every transport organization itself has to decide whether to adopt the standard and when. But transport associations covering about two thirds of the German population have already made a commitment to start introducing eTicket Germany by 2015, so the pressure to join the initiative is present. Through Aprikose transport organizations shall get the opportunity to offer inter-/multimodal transportation services to their passengers in the future using the eTicket Germany.

Project participants of Aprikose are the University Stuttgart as methodological partner, the highQ Computerloesungen GmbH (in short highQ, located in Freiburg and Stuttgart) as technical partner and several industrial partners from the public transportation sector like the Kreisverkehr Schwäbisch Hall (KVSH) and the Hamburger Verkehrsverbund (HVV). The University Stuttgart i.e. the chair of information systems II from Prof. Herzwurm as academic partner contributes to the project with its experience and competence in Requirements and Service Engineering as well as IT product management. highQ is currently among the technology leaders in the adoption of eTicket Germany. They are participating in a number of research projects investigating aspects of the technological infrastructure necessary for the nation-wide implementation of eTicket Germany. KVSH and HVV both represent leading regions in the adoption of eTicket Germany. Within the HVV it is possible to buy and use single tickets for direct occasional travelers in one subregion using the eTicket HVV. Within the KVSH travelers can check in at the start of their journey and check out at the end with the background system determining the right fare automatically. So both regions have done first steps in the "eTicket Germany world" and represent by this ideal partners in the sense of model regions for the project.

This paper describes the application of Quality Function Deployment (QFD)[2] within the research project Aprikose. The project is still in progress, so the paper contains first results and insights gained during the QFD application so far. Section 2 comprises of the main surrounding conditions the QFD application has to cope with. Section 3 describes the QFD application and its implications under the given circumstances. Finally section 4 summarizes the findings and gives an outlook of the prospective course of action in Aprikose.

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[2] For more details on QFD see e.g. [Akao 1990] and [Ficalora and Cohen 2009]. For more details on Software QFD see [Herzwurm et al. 2000] and on the application of QFD in the field of public transportation see [Helferich et al. 2011].

## 2 Surrounding conditions of the QFD application

As pointed out in section 1 the research project Aprikose aims primarily at providing small and medium-sized companies a cost-effective and easy way of participating as one service supplier within a network of transport organization using the eTicket Germany. Through Aprikose transport organizations and associations shall get the opportunity to offer combined transportation services covering multiple modes of transportation (so called intermodal transportation) to their passengers.

This implicates the central determining factor for the project: the common technical and organizational standard for electronic ticketing in Germany, the VDV-Core-Application (VDV-CA). The standard defines processes, data elements and interfaces between the roles of potential users of the VDV-CA. Its specification comprises of about 1800 pages and is frequently changing (currently in the version 1.109).[3] To deal with such a complex document in the daily routine is for most of the public transport organizations nearly impossible. To be accepted in practice an "out-of-the-box"-solution for the entry into the "eTicket Germany world" is mandatory, ideally easy to install and maintain.

This in mind, the core project team consisting of highQ and the University Stuttgart came up with a first solution idea in the sense of project scoping and setting the relevant system boundaries for the forthcoming QFD process: why not use a so called appliance? Many home users are very familiar with appliances e.g. in the form of wireless routers or network attached storages (NAS). These devices are easy to install and require almost no action from outside during normal operation. For more complex environments like larger companies their value is limited, but in the standard environment of home internet users they work in most cases properly. An appliance often incorporates both hardware and software. It integrates and configures all the required functional components like firewalls, security mechanisms in the case of routers in a dedicated unit often purchased from a single vendor [Hitachi 2013].

The vision of Aprikose is that such an appliance shall serve somewhat as the gateway for transport organizations to apply the VDV-CA standard. But there is not one way to join the VDV-CA network. The standard defines a complex role model for the participating partners (see figure 1).

[3] For an overview of the VDV-KA version 1.107 and the revisions in the past see the so called "main document" including the basic object model [VDV-KA 2010].

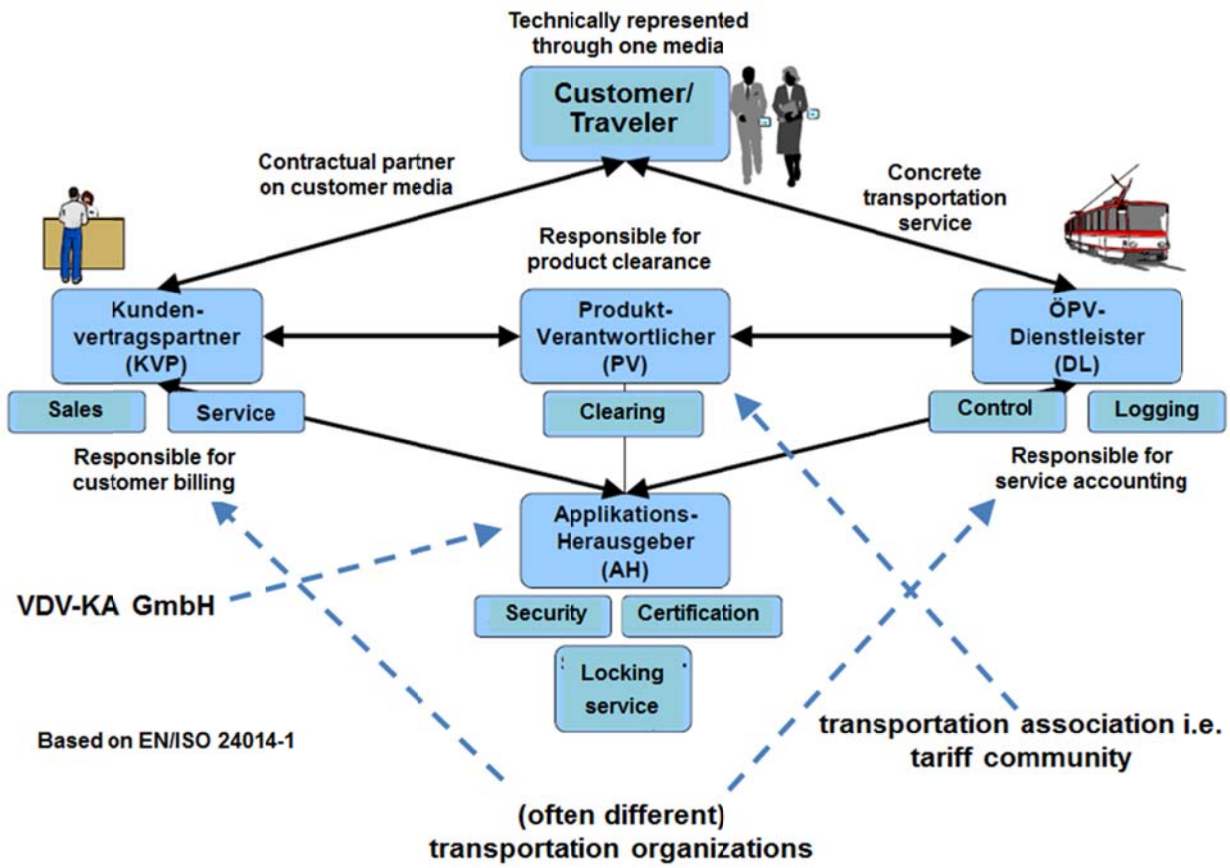


**Fig. 1: Role model of the VDV-Core-Application (on the basis of [VDV-KA 2010, p. 21])**

As shown in figure 1 a transport organization can be the main contractual partner to customers (so called "Kundenvertragspartner" – KVP) as well as one transportation service provider within a concrete chain of travel of one passenger (so called "ÖPV-Dienstleister" – DL). There are different responsibilities coming along with these roles. The DL performs the transportation services to the travelers which the KVP charges to the customer's account. The KVP is responsible for the customer billing, the DL is in charge of the correct service accounting. In between normally a transport association as tariff community is responsible for the correct product clearance (so called "Produktverantwortlicher" – PV). The VDV-CA is administered and edited by the VDV-KA GmbH & Co. KG in Cologne. In that function the VDV-KA GmbH serves as the one central authority providing security and locking services (so called "Applikationsherausgeber" – AH).

These different responsibilities and perspectives come along with different background systems like KVP-systems, PV-systems and so on. These systems are often several years in use and vary significantly in their functional breadth, from small Microsoft Excel implementations to big enterprise solutions running on central servers. Against this background many different application scenarios are not only possible but reality for the potential customers of an Aprikose appliance. Aprikose could be an alternative as well as a supplement to existing systems. It could provide a wide range of necessary functionalities within the network of mobility service providers; it could act as a permanent technical system integrator; or it could serve "only" as a puristic communication gateway between the existing systems. Figure 2 shows a rough schema with which we started the first QFD workshops with representatives from transport organizations and associations as well the VDV-KA GmbH to illustrate these potential usage scenarios of the appliance.

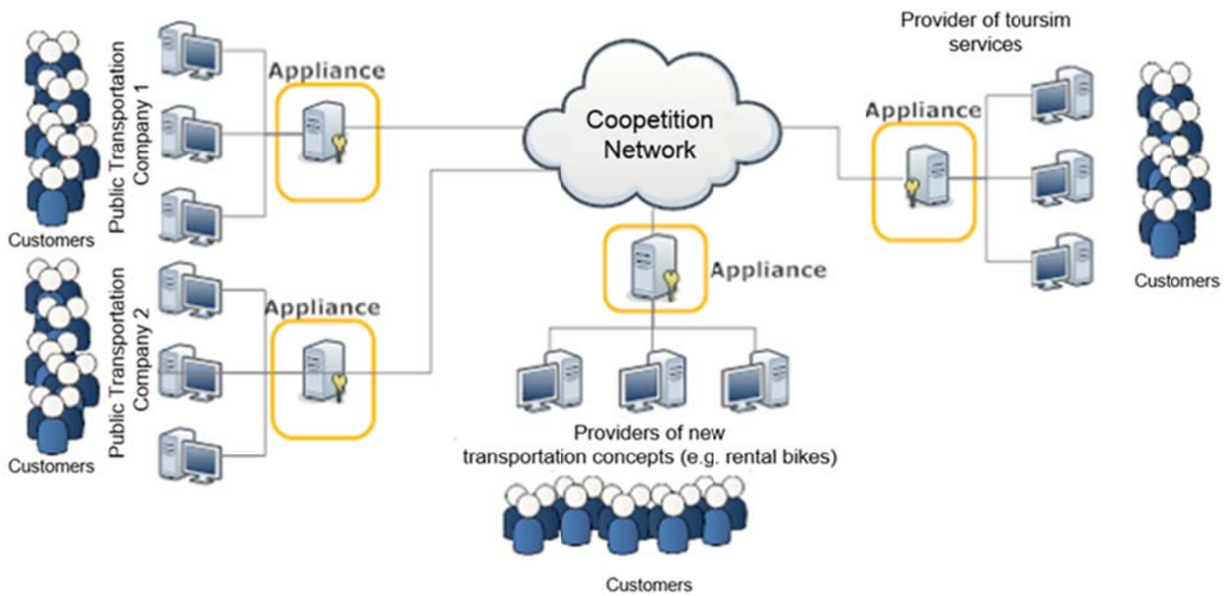


**Fig. 2: Basic application scenarios of an appliance in a network of mobility service providers**

But the customer deployment (see e. g. [Herzwurm et al. 2000]) part of the project got even more complicated. Not only that a transport organization usually acts for its own regional customers as KVP; for travelers using intermodal transportation services as DL; and possibly even as a PV responsible for the tariffs in a subregion of a bigger transport association. In the german public transportation landscape it is common that these roles are held by different organizations being competitors in the past but now having to cooperate to serve the same traveler. The eTicket Germany is explicitly designed to allow interoperability between the various local and regional transport providers to provide inter-/multimodal mobility services to travelers. So there is a duality of cooperation and competition, which influence the market actor's actions without cooperating with one another directly.

This market phenomenon of so called "co-opetition", an artificial word composed of cooperation and competition, arises when companies interact having partial congruence of interests (see e.g. [Bengtsson and Kock 2000] and [Brandenburger and Nalebuff 1997]). Interoperable electronic ticketing, intermodal transportation and multimodal services require technical as well as organizational networking of the market actors and by that cooperation. But e.g. the supplier of rental bikes remains still a competitor of the public bus transport organization. Co-opetition networks often occur when companies have to work together in the research for new products to be offered to customers (e.g. the intermodal transport services), at the same time that they struggle to achieve competitive advantage in exploitation of the knowledge created together. Another example for such a co-opetition network is the field of air transportation where airlines build alliances to offer their customers a broader range of flight destinations but at the same time compete with one another on certain flight routes. It is like having "war and peace" at the same time, competition and cooperation. Essential is that there are somewhat complementary products that can be combined with one another: buying one product e.g. a ticket to an end destination within the travel network of HVV raises the chance of the local bus transportation organization to sell an add-on ticket to the customer for traveling further.

The situation of co-opetition between the potential customers of Aprikose leads to a difficult set-up for the team composition in the QFD workshops. QFD profits essentially from an open minded atmosphere where ideas can be stated without the fear that someone else of the participants adapts the ideas to his own competitive advantage. This is even more important in the innovative field Aprikose takes place. But the public transportation industry in Germany is still stuck in the traditional role allocation of competition rather than cooperation. So before and at the beginning of the workshops many efforts were needed to convince the industrial partners that cooperation among another would lead to a higher value creation if compared to the value created without interaction with one another.

## 3 QFD process outline and its implications

As described in section 2 the main challenges of the QFD application in this setting are the innovative character of the application domain and the heterogeneous stakeholder interests. So the first goal within the project was to reach a common understanding of the customer‘s problems and requirements. For that reason we conducted two QFD workshops with potential customers of the two model regions, Hamburg (HVV) and Schwäbisch Hall (KVSH). Consciously we invited rather more potential customers than recommended for standard moderated workshops, but we wanted to get as much input as possible from the different customer perspectives.

The atmosphere of co-opetition within the workshop required methodical alignments in the elicitation and negotiation stage of the QFD application. In particular we addressed each customer's perspective by explicitly giving each participant the chance to reflect the evolving requirements using the following questions within the Voice of Customer Analysis (VoCA) Workshop: Do you understand the customer requirement? Is it necessary to add something to the requirement? Is it necessary to break down the requirement into more detail? Are there similar requirements? Which feature or ability could fulfill this requirement? Knowing that the last question is about seeking for concrete solutions, we asked it anyway to get especially the arguments from the technical experts on the customer side in the innovative field of the VDV-CA. Some impressions from the workshops are given in figure 3.

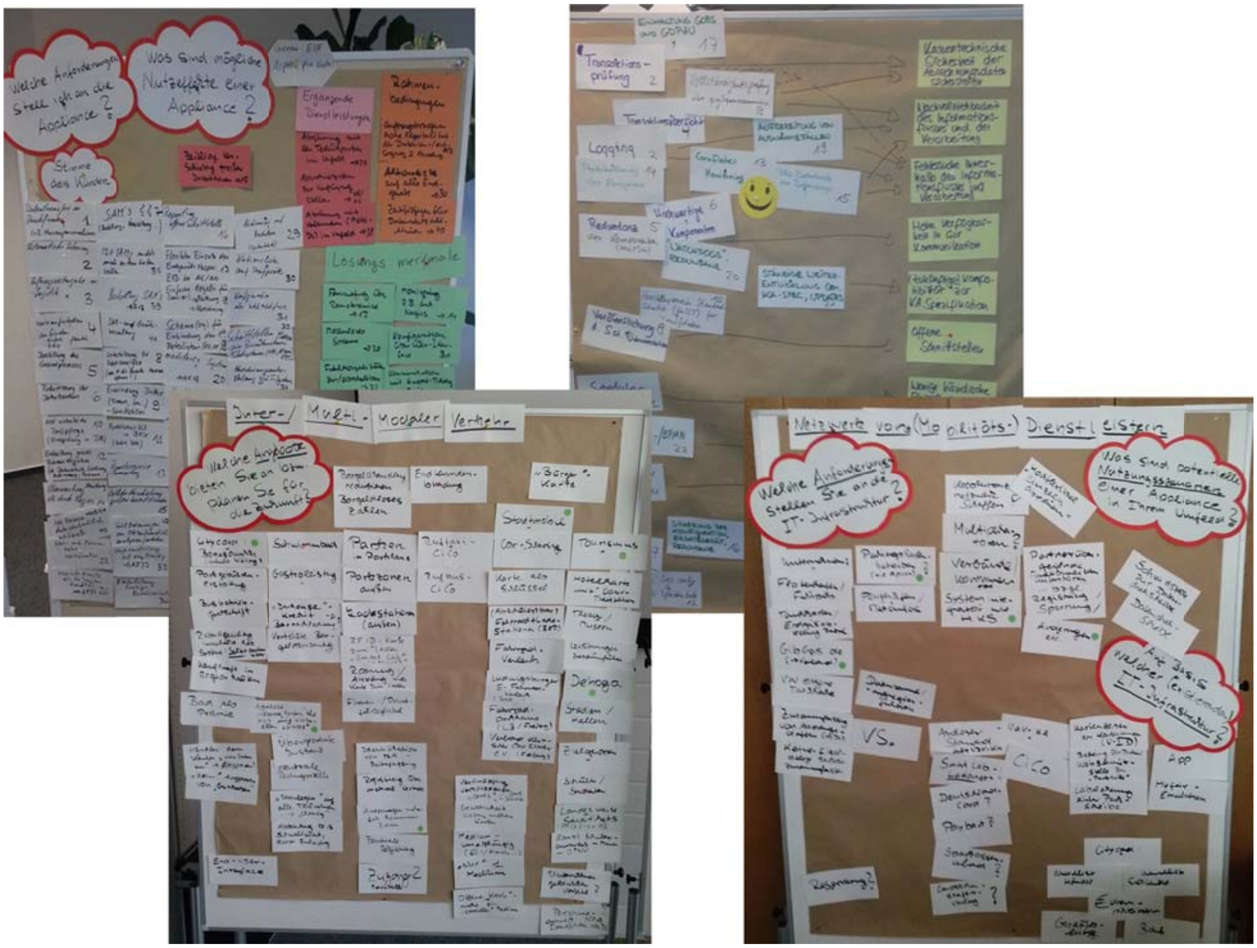


**Fig. 3: Examples of visual documentation in the QFD workshops**

One implication of involving rather (too) many customers in the workshops was that for the most only broad and general requirements were identified. This led to the effect that the requirements gave at the first glance only little direct guidance for first development actions. Especially the participating developers had little to take home after the first workshop. This caused a feeling of uncertainty and frustration on their side. One reason for this effect was that our initial project scoping (see section 2) was to rough. The identified usage scenarios of the appliance in the VDV-CA environment were as good as we could describe them at the beginning of the project. But they set the potential system boundaries not tight enough to focus the discussions in the workshops on the central requirements for an appliance which offers transportation organizations the possibility to join a co-opetition network in the field of mobility- and complementary services easily, cost-efficiently and securely.

The second main consequence we experienced during the two VoCA workshops was that we came up with more differences than similarities in the elicited customer requirements. Of altogether 71 customer requirements only 7 requirements represented exactly the same meaning in both workshops. Of course, among these 7 requirements were with "high operational availability" and "communication/interoperability with third party systems" two of the top-requirements. But anyway, this was a surprise to us. Obviously many regional differences are present, also resulting from the different VDV-CA roles (see section 2) and the various sizes of the involved transport organizations and associations. But even within one company we identified contrary views, especially when looking at the customers' priorities. The reasons for this effect were different perspectives on the subject of co-opetition networks. From a business view costs but also the chances of selling complementary products are relevant. From a technical point of view the technical challenges of connecting different systems and actors are more present.

According to [Schockert and Herzwurm 2011] we choose a group discussion approach for prioritizing the requirements. By this we wanted to enhance the common understanding of the evolved requirements and to secure a high transparency of the QFD process to all participants. At first all customer representatives answered two questions: How important is the fulfillment of a dedicated requirement X to you? (1 not important – 10 very, very important) How do you assess an insufficient consideration of requirement X? (positively, neutrally, slightly negatively, negatively, very negatively). To involve even the developers in the prioritization process we requested them to answer the same questions in the way they imagine the customers would answer them. By this the developers could reflect their perception about the customer views. Figure 4 gives an example of a prioritization sheet of the customer requirements (already aggregated for the customers of one workshop).

| | Customer Requirements | Wichtigkeit aus der Perspektive von: Ergebnisse aggregiert | Max. Wichtigkeit | Min. Wichtigkeit | ABWEICHUNG | ... deren aktuelle Zufriedenheit | | Absolut | Relativ |
|---|---|---|---|---|---|---|---|---|---|
| 35 | hohe Verfügbarkeit | 8,5 | 9 | 8 | 1 | 4,5 | sehr negativ / sehr nachteilig | 38,25 | 4,7% |
| 16 | Kommunikation mit Drittsystemen | 8,2 | 10 | 5 | 5 | 4,2 | sehr negativ / sehr nachteilig | 34,0278 | 4,2% |
| 36 | Benutzerführung | 8,2 | 9 | 7 | 2 | 3,7 | negativ/nachteilig | 29,9444 | 3,7% |
| 4 | Verkaufstellen einfach anbinden | 7,3 | 9 | 6 | 3 | 4,0 | sehr negativ / sehr nachteilig | 29,3333 | 3,6% |
| 5 | Verkaufstellen sicher anbinden | 7,3 | 8 | 6 | 2 | 4,0 | sehr negativ / sehr nachteilig | 29,3333 | 3,6% |
| 10 | Überischt über Status und Verteilung der sicherheitsrelevanten Module | 7,7 | 9 | 6 | 3 | 3,7 | negativ/nachteilig | 28,1111 | 3,4% |
| 12 | Verbergen der Komplexität des Sicherheitsmanagements | 8,0 | 10 | 6 | 4 | 3,5 | negativ/nachteilig | 28 | 3,4% |
| 22 | Systemstatus überwachen | 7,2 | 8 | 6 | 2 | 3,7 | negativ/nachteilig | 26,2778 | 3,2% |
| 25 | einfache Erweiterbarkeit | 7,2 | 9 | 3 | 6 | 3,5 | negativ/nachteilig | 25,0833 | 3,1% |
| 32 | Einfach zentral konfigurieren können | 7,5 | 9 | 6 | 3 | 3,3 | negativ/nachteilig | 25 | 3,1% |
| 7 | Rückmeldung über Prozessabschluss | 7,0 | 8 | 5 | 3 | 3,5 | negativ/nachteilig | 24,5 | 3,0% |
| 8 | Rückmeldung über relevante Prozessschritte | 7,3 | 9 | 3 | 6 | 3,3 | negativ/nachteilig | 24,4444 | 3,0% |
| 6 | flexibel an die Technik der Verkaufstellen anbinden | 6,8 | 8 | 5 | 3 | 3,5 | negativ/nachteilig | 23,9167 | 2,9% |
| 15 | Fehlersuche im Systemübergreifenden Informationsfluss | 6,7 | 8 | 4 | 4 | 3,5 | negativ/nachteilig | 23,3333 | 2,9% |
| 1 | Automatisierter Datentransfer zu Druckfirmen | 6,5 | 9 | 2 | 7 | 3,5 | negativ/nachteilig | 22,75 | 2,8% |
| 34 | Individualisierbare Nutzung (Anpassung) | 6,7 | 8 | 4 | 4 | 3,3 | negativ/nachteilig | 22,2222 | 2,7% |
| 18 | Integration in vorhandene IT-Strukturen bei Netzwerk-Partner | 6,5 | 8 | 5 | 3 | 3,3 | negativ/nachteilig | 21,6667 | 2,7% |
| 19 | Gewährleistung gesetzlicher Datenschutzrichtlinien | 6,7 | 9 | 4 | 5 | 3,0 | negativ/nachteilig | 20 | 2,5% |
| 21 | zentrale Administrierbarkeit (nach Wunsch) | 6,0 | 8 | 4 | 4 | 3,3 | negativ/nachteilig | 20 | 2,5% |
| 23 | konfigurierbarer Export zur Weiterverarbeitung | 6,7 | 8 | 4 | 4 | 3,0 | negativ/nachteilig | 20 | 2,5% |
| 37 | personalisierte/individuelle Verknüpfung von Angebot und Verkauf | 6,7 | 10 | 5 | 5 | 3,0 | negativ/nachteilig | 20 | 2,5% |
| 9 | Übersicht über die Zusammenhänge der Daten und Datenflüsse | 6,5 | 9 | 3 | 6 | 3,0 | negativ/nachteilig | 19,5 | 2,4% |
| 30 | Dienstleister übergreifendes Angebotserstellung | 6,8 | 9 | 4 | 5 | 2,8 | leicht negativ/schade | 19,3611 | 2,4% |
| 13 | Hilfestellung zur Konfiguration und Bestellung der SAM`s | 6,3 | 8 | 2 | 6 | 3,0 | negativ/nachteilig | 19 | 2,3% |
| 26 | Mit der Vielfalt der Nutzermedien zurechtkommen | 6,2 | 9 | 2 | 7 | 3,0 | negativ/nachteilig | 18,5 | 2,3% |
| 14 | Übericht über die Zuordnung der Endgeräte zu SAM`s | 5,8 | 8 | 3 | 5 | 3,2 | negativ/nachteilig | 18,4722 | 2,3% |
| 24 | Fähigkeit zur Abbildung von Kundenprozessen, wie Nutzung, Abrechnung usw | 6,5 | 9 | 4 | 5 | 2,8 | leicht negativ/schade | 18,4167 | 2,3% |
| 38 | Unterstützung flexibler Bezahlvarianten | 6,0 | 9 | 3 | 6 | 3,0 | negativ/nachteilig | 18 | 2,2% |
| 33 | Controlling der Abrechnung des Sicherheitsmanagements | 5,8 | 8 | 5 | 3 | 2,8 | leicht negativ/schade | 16,5278 | 2,0% |
| 27 | Verteilung der Transaktionen zu allen Beteiligten | 5,7 | 9 | 2 | 7 | 2,8 | leicht negativ/schade | 16,0556 | 2,0% |
| 2 | Automatische Sicherung des Komplettsystems der Appliance | 5,3 | 8 | 2 | 6 | 3,0 | negativ/nachteilig | 16 | 2,0% |
| 20 | Unterstützung bei der Administration gesetzlicher Datenschutzrichtlinien | 5,3 | 7 | 3 | 4 | 3,0 | negativ/nachteilig | 16 | 2,0% |
| 17 | Abwicklung von Logistikaufträgen | 5,5 | 10 | 1 | 9 | 2,8 | leicht negativ/schade | 15,5833 | 1,9% |
| 31 | Einheitliche Tarifpflege | 5,8 | 8 | 2 | 6 | 2,7 | leicht negativ/schade | 15,5556 | 1,9% |
| 29 | Kundenbezogene Informationen abrufen können | 5,5 | 8 | 4 | 4 | 2,7 | leicht negativ/schade | 14,6667 | 1,8% |
| 3 | Aggregierte Nutzungs- und Nachfrageanalyse | 5,0 | 8 | 1 | 7 | 2,7 | leicht negativ/schade | 13,3333 | 1,6% |
| 28 | Konfigurierbare Rechnungsstellung | 4,8 | 9 | 2 | 7 | 2,7 | leicht negativ/schade | 12,8889 | 1,6% |
| 11 | Eingabe Definition von Sicherheitsmerkmalen | 5,2 | 7 | 2 | 5 | 2,3 | leicht negativ/schade | 12,0556 | 1,5% |
| | MW | 6,5 | | | | | | | |
| | Sum | 248,7 | | | | | Sum | 816,111 | |

**Fig. 4: Example of a prioritization sheet of customer requirements**

All assessments were discussed with all participants within the workshops. As mentioned above, many differences remained, especially comparing the results of the two model regions. On the one hand we were satisfied to get a more comprehensive and differentiated picture of the customer perspectives. But on the other hand this left us with the problem of aggregating the results of the two workshops to ONE picture to give the developers more concrete guidance for first development actions to produce a first prototype of the appliance.

To meet this challenge we used a requirements hierarchy in form of altogether 13 requirements categories for the identified 71 requirements. And to be mathematically more precise we used a pairwise comparison to prioritize the requirement categories by each customer like the one used in the Analytic Hierarchy Process (AHP, see for the application within QFD e.g. [Vongpatanasin and Mazur 2009] and in general [Saaty 2008]). We don't claim to have got mathematically sound results by combining this prioritization on ratio scales with the one on ordinale scales used for each single requirement (for an explanation of the importance to get mathematically sound results see for example [Jesso-White and Mazur 2010]). But this hands-on procedure served our purpose of integrating the results of the two workshops.

By analyzing the weights of the requirement categories the participants of BOTH workshops gave and by combining them with the evaluation of each single requirement within the categories we came up with an extended ABC-classification of the requirements in overall 5 ranking groups. The first two ranking groups with altogether 18 single requirements then served as the input for the follow-up Voice of the Engineer Analysis Workshop to transfer the customer voice into altogether 59 solution characteristics. We used two matrices (like Software-HoQs, see e.g. [Herzwurm et al. 2000]) – one on the category level (see fig. 5) and one on the element level – to assure consistency of the results. And by focusing in that way we coped with the above mentioned problem of the developers who felt left alone with too broad and general requirements.

| *Legend:*<br>The fulfillment of the criteria [top] contributes<br>9 : inevitable and very strongly<br>3 : appreciable but maybe limited<br>1 : possibly and only limited<br>0 : indirectly or maybe not at all<br>to the fulfillment of the requirement [left]. | **Importance** | **Display** | **Failover** | **Data Management** | **Data Security** | **Installation and configuration** | **Control and testing** | **Modularity** | **Interfaces and Communication** | **Monitoring** | **Updates** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Customer requirements** | | | | | | | | | | | |
| **Administration** | **13,60%** | 9 | 3 | 3 | 1 | 9 | 3 | 3 | | 9 | 9 |
| **Event handling** | **12,90%** | | | 1 | | | 9 | | 9 | 9 | |
| **Operational management** | **12,40%** | 9 | 3 | | 3 | 1 | 3 | | 3 | 3 | 1 |
| **Flexibility** | **11,10%** | | | 3 | | 3 | | 9 | 9 | | 3 |
| **Security** | **9,30%** | 1 | 3 | 3 | 9 | 1 | 1 | | | 3 | 3 |
| **Compliance** | **8,00%** | | 3 | 3 | 9 | | 1 | | | 1 | |
| **Availability** | **7,60%** | | 9 | | | | 3 | 1 | | 9 | 3 |
| **Administrate Standards** | **6,50%** | | | | | 3 | | 1 | 9 | | 9 |
| **Individualization** | **5,70%** | 3 | | 3 | | 3 | | 3 | | | |
| **Usability** | **5,40%** | 9 | | | | 9 | 3 | | | 3 | 3 |
| **Clearance** | **4,40%** | 1 | | | | | 9 | | 3 | 3 | |
| **Support** | **2,20%** | 1 | | | | 3 | 1 | | | 1 | 3 |
| **Pricing Model** | **0,80%** | | | | | | | 3 | | | |
| | **99,90%** | | | | | | | | | | |
| **Absolute importance** | | **3,2** | **2,0** | **1,6** | **2,1** | **2,7** | **2,9** | **1,7** | **3,2** | **4,1** | **3,0** |
| **Relative importance** | | **11,9%** | **7,5%** | **5,9%** | **7,8%** | **10,2%** | **11,0%** | **6,6%** | **12,3%** | **15,5%** | **11,3%** |
| **Rank** | | **3** | **8** | **10** | **7** | **6** | **5** | **9** | **2** | **1** | **4** |

**Fig. 5: Group – House of Quality for transferring requirements categories into solution categories**

The analysis came up with "Monitoring" as the by far most important solution category (in the columns of figure 5). It primarily aims at ensuring a reliable operation of the appliance, functionally as well as technically. In the first increment of Aprikose, this is mainly realized by the possibility of monitoring transaction data (i.e. the information flow in the network) through an integrated open source solution (ICINGA[4]). The second most important solution category focuses on the interfaces for communication between Aprikose and third-party-systems, especially in the environment of the VDV-CA. This reflects the core functionality of the appliance: the exchange and the conversion of data as well as the connection of different IT system landscapes. The four following solution groups regarding display, updates, control and testing as well as installation and configuration especially focuses on the smooth operation of the appliance requiring as less intervention as possible. For this purpose, a real time overview of all current and past transactions as well as an outsourcing (and with that a backup, possibly in the cloud) of the system configuration data to ease administration have been realized.

## 4 Summary and Outlook

The paper described the application of QFD within the research project "Aprikose" funded by the German federal ministry of Education and Research. The project is still in progress, so the paper contains first results and insights gained during the QFD application so far. Aprikose aims primarily at developing a hard-/software appliance which will provide the participating public transport organizations with the opportunity to offer combined transportation services to their passengers. The project background comprises of the (((eTicket Germany initiative heading for a technical and organizational standard of electronic fare management in Germany, the so called VDV-Core-Application (VDV-CA). With the eTicket Germany passengers shall travel seamlessly by using just one media while travelling with different public transport organizations. At the same time the entry threshold for passengers to use public transportation should be as low as possible: easy boarding; possible end-to-end travelling from the starting location to the final destination; no need for knowing the (possibly complex) pricing models; transparent and secure clearance. And ideally beyond that, other inter-/multimodal services like car-sharing or payment for touristic attractions can be combined with the media.

Main challenges of the application of QFD in this setting are the innovative character of the application domain and the heterogeneous stakeholder interests. These results from the competition between the transport organizations and the somewhat missing insight that cooperation with each other would lead to a higher value creation and competitive advantage if compared to the value created without interaction with one another. This so-called environment of co-opetition required methodical alignments in elicitation, negotiation, and prioritization of requirements considering the different stakeholder viewpoints as well as user roles within the VDV-CA.

As a consequence of the insights gained during the QFD usage so far, the QFD application is planned to take place in increments representing different product versions at different stages of functional extension (see figure 6).

[4] See https://www.icinga.org/

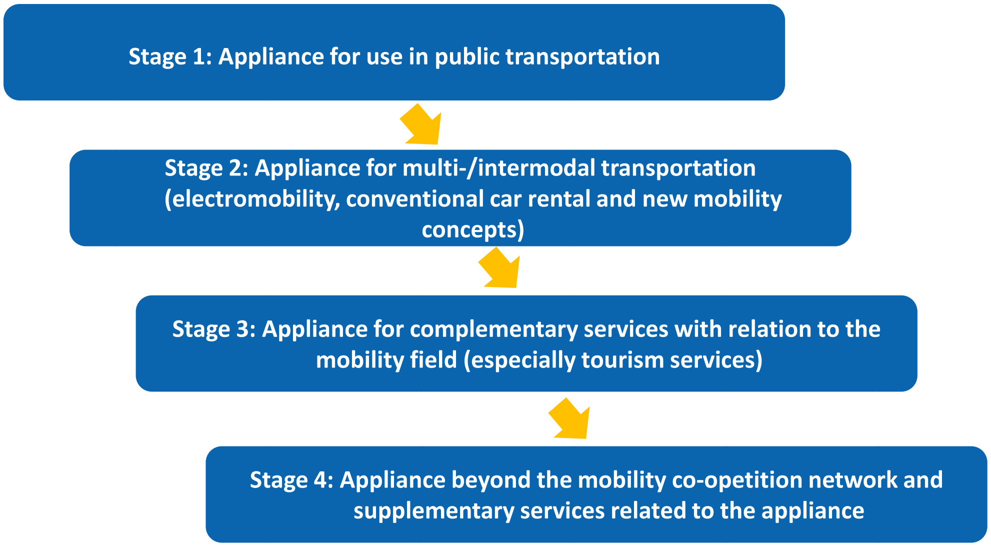


**Fig. 6: Incremental development of the appliance**

We have already started with stage 2 expanding the focus to the multi-/intermodal transportation services. We discovered that – although we have an even more heterogeneous topic and team composition than in the first workshops only involving public transport organizations – the QFD application is more focused. This is mainly caused by the fact that the system boundaries and usage scenarios of the appliance are more definite after the first QFD round.

In this sense we apply the Continuous QFD approach ([Herzwurm et al. 2000] and [Herzwurm et al. 2012]), an incremental version of QFD particularly well suited to develop customer-oriented software and services in dynamic and uncertain application domains (so-called "fuzzy development tasks"). In a way, the QFD process within Aprikose is continuously consisting of similar QFD "loops" (or Continuous QFD cycles) covering the same steps within each increment development.

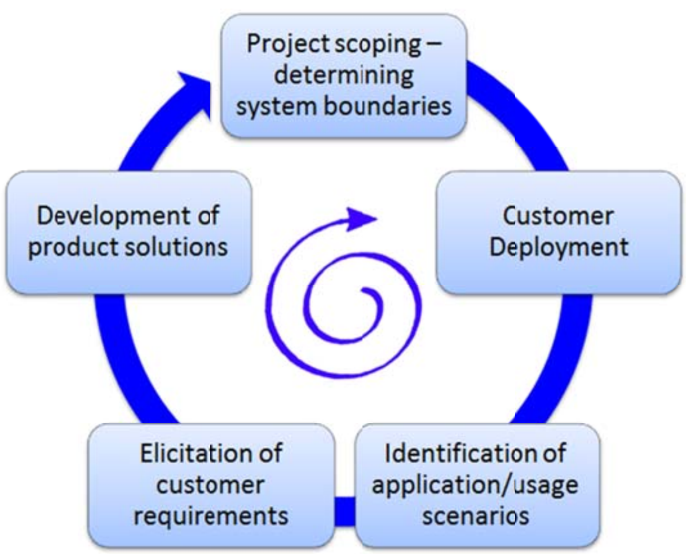


**Fig. 7: The QFD loop – ongoing QFD steps within each increment development**

At least the first two of the increments will be completed by the end of the year 2013. Within each QFD loop the focus will shift, from the public transportation sector via the multi-/intermodal transportation and complementary services to even the perspective beyond the mobility co-opetition network. We are convinced that there are more usage scenarios for appliances like Aprikose even outside the mobility domain: Why not adopt the appliance technology and general functionality of being a data converter within heterogeneous system environments to other co-opetition networks?

Based on a resolution of the german Bundestag the research project Aprikose is funded by the German federal ministry of Education and Research.
For further information see www.aprikose.wi.uni-stuttgart.de.

## Literature

Akao, Y. (1990): Quality Function Deployment: Integrating Customer Requirements into Product Design. Translated by Glenn H. Mazur, Cambridge, MA.

Bengtsson, M., Kock, S. (2000): Coopetition in Business Networks – to Cooperate and Compete Simultaneously Industrial Marketing Management, Vol. 29, pp 411–426.

Brandenburger, A. M., Nalebuff, B. J. (1996): Co-opetition. A Revolution Mindset That Combines Competition and Cooperation. London, Broadway Business.

Ficalora, J. P., Cohen, L. (2009): Quality Function Deployment and Six Sigma, A QFD Handbook, Upper Saddle River, NJ, 2009.

Helferich, A., Pelzl, N., Herzwurm, G., Hornig, T., Fondrier, C. (2011): The Use of QFD-PPP 2.0 to enhance an Electronic Fare Management System. In: Proceedings of the 17th International QFD Symposium, Stuttgart.

Herzwurm, G., Pietsch, W., Schockert, S, Tauterat, T. (2012): QFD for Cloud Computing. In: Proceedings of the 18th International Symposium on Quality Function Deployment. International Symposium on Quality Function Deployment (ISQFD). Yamanashi, Japan.

Herzwurm, G., Schockert, S., Mellis, W. (2000): Joint requirements engineering. QFD for rapid customer-focused software and internet-development. Braunschweig, Vieweg.

Hitachi ID Systems, Inc. (2013): Appliances vs. Traditional Servers: Pros and Cons. http://hitachi-id.com/docs/appliance-server-pros-cons.pdf, access date 2013-08-17.

Jesso-White, J., Mazur, G. (2010): DREAM/QFD to Redesign New Physician Orientation at Rutland Regional Medical Center. In: Proceedings of the International Symposium on QFD, Portland, pp. 85–97.

Saaty, T.L. (2008): Decision making with the analytic hierarchy process. International Journal Services Sciences, vol. 1, no. 1, pp. 83–98.

Schockert, S., Herzwurm, G. (2011): Investigating the requirements prioritization process in customer oriented development projects. In: Proceedings of the 17th International QFD Symposium, Stuttgart.

VDV-KA (2010): VDV-Kernapplikation – KA_Technische Spezifikation – Hauptdokument mit Basisobjektmodell (BOM). Stand: August 2010. http://www.eticket-deutschland.de/spec-hd-bomv1107_1. pdfx?forced=false, access date 2013-08-17 (in german).

Vongpatanasin, T.; Mazur, G. (2009): Why we drink beer: Using QFD, Kansei, and AHP to Understand How Consumers Identify with Brands. In: Proceedings of the 15th International Symposium on Quality Function Deployment in Monterrey, Mexico, 2009, pp. 33-44.

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