

Quality of Service: Concept Analysis

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Abstract. This paper summarizes the state of affairs of the doctoral research. Different views of the concept of quality are examined, e.g. product-based, user-based or manufacturing-based view. Finally, the term quality of service is discussed in consideration to web service compositions.

Keywords. Quality, quality of service

Introduction

The main objective of this paper is to summarize the state of affairs of the doctoral research that is in its preliminary phase. The goal of this research is analysis and improvement of web service composition methods. Web service compositions have been investigated by many researchers and a number of different approaches and methods have been proposed in this area. Also a number of open standards facilitating composition of web services have been developed by OMG, OASIS and other standardization bodies. However the achieved results still leave a lot of room for various improvements. In other words, the problem of composition still has not been solved ultimately and more research work, especially on composition of semantic web services is needed. The doctoral research presented concentrates on the methods of quality-driven composition of semantic web services. In this approach quality constraints and preferences are assigned to composite services in addition to the functional requirements. Thus the component services should be selected in such a way that their composition would meet those constraints and preferences in the possible best way. It means that it is possible only to approximate the required quality and that a number of acceptable solutions exist. So, the best solution should be chosen. Besides, this problem is domain-dependent one because the quality of service (QoS) in each application domain is described in terms of different quality characteristics. Up to date, general web service quality model still is under development. In addition, even in cases when only domain-independent characteristics of quality are taken into account, not all quality requirements and preferences can be decomposed, allocated to component services and flowdowned to component service. It is unknown which domain independent quality characteristics can be expressed by characteristics of candidate component services. One more problem is that web services run in highly dynamic environment, in which the number of component services providing required

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functionality and acceptable QoS is constantly changing. Consequently the run time selections of component service from candidates choose at design time should be done.

In this phase of doctoral research, we aim to define in more precise way the term *Quality of Service*, to understand why the current methods that are used to predict or/and evaluate the QoS for composition of semantic web services are still not enough efficient and to state the aims and tasks of further research. In order to achieve this goal, the conceptual analysis of the concepts *Quality* and *QoS* should be done. We attempt to answer the question: In which extent it is possible to generalize the different meanings of the term *Quality of Service* and to build the ontological model that defines this concept in a formal way? According to Guarino [1], concepts “*have an internal structure, as they “bundle” together further concepts or binary relations (roles)*”. By ontological model of QoS we mean formal representation of internal structure of this concept. The paper surveys briefly the results of the analysis and generalizes the findings.

1. What Is the Quality?

To answer the question, what is the meaning of the term “*Quality of Service*”, is far not a simple task. According to Lafuente [2], the concept of Quality of Service still remains flue and its definitions depend strongly on the research context and are not adapted to other contexts. Up to date, there is no common understanding even of the term “*quality*”. The five different meanings of the term quality have been distinguished by [3] and investigated by a number of other authors [4, 5, 6, 7, 8, 9, 10]:

Transcendental (or metaphysical) view: According to this view, quality is synonymous with “innate excellence.” It is both absolute and universally recognizable, a mark of uncompromising standards and high achievement [3]. However, it means that quality is something that can be recognized but not defined or, in other words, it is simple, unanalyzable property, an ideal, towards which we should strive but which can never be achieved in objective reality. Perhaps the best description of quality based on the transcendental view has been done by Pirsig: in this famous philosophical novel on the nature of quality:

“...even though Quality cannot be defined, you know what it is. ... Quality is neither a part of mind, nor is it a part of matter. It is a third entity which is independent of the two. ... Quality isn't a substance. Neither is it a method. It's outside of both. ... It's the goal toward which method is aimed” [11].

However, such view of quality has little practical utility, may be except for advertising campaigns. Such quality cannot be measured by experts and can be perceived through experience alone. Besides, attributes of “ideal” quality are changing over time. Thus, in real-world situations it is more practical to define quality in some constructive way. Although such definition defines only some approximation of ideal quality, it may be more useful.

Product-Based View: This view defines quality on the basis of quantifiable and measurable characteristics or attributes. In other words, it examines the quality from inside perspective and assumes that a product which has good internal properties has also good external properties. For example, this view is supported in the ISO-9004 standard, where quality is defined as fitness for use, performance, safety and dependability. Sometimes this view is called quality of design [12]. The disadvantages of this approach are that it do not take into account preferences of a particular user and

assumes that the absence or presence of an attribute implies higher quality. In other words, it assumes that the greater the amount of a desired attribute possessed by a thing, the higher is the quality. According to Leffler, “*Quality refers to the amounts of the unpriced attributes contained in each unit of the priced attribute*” [13].

User-Based View: This view defines quality as fitness for purpose. Sometimes this view is called market-place quality or consumer preference [12]. It is based on the idea that quality is an individual matter, and things that best satisfy user preferences have the highest quality. Thus this understanding of the quality is context-dependent because the judgment about the quality of a thing depends on the aims and goals for which this thing is intended to be used. Despite the fact that the user-based view is highly subjective, it is more concrete as transcendental view because it is based on such product characteristics as usability, reliability, performance and efficiency evaluated from the user’s point of view. So, this view equates customer satisfaction with the quality. According to it, product is of high quality if it satisfies a large number of users.

The user-based view is perhaps the most common view about the quality and even in the definitions of quality given by originators of quality management theory, such as Crosby and Juran the quality is defined as “*conformance to user requirements*” [14] or as “*fitness for use*” [12]. However different users place different weights on the various quality characteristics, So, the most important problems with application of user-based view in practice are that it is unclear how to sum up varying individual preferences of particular users and how to know which attributes are for quality and which for user satisfaction. It is very difficult to develop an unbiased statistical procedure that aggregates such widely varying subjective preferences [15]. In addition, most researchers in the service field claim that, at least for services, quality and customer satisfaction are separate concepts although they share a close relationship [16]. The perceived quality of service tends to be stable construct, whereas a user’s satisfaction may change for one transaction to another [15]. User’s satisfaction can result from a large number of non-quality issues, such as needs, equity, perceptions of fairness. On the other hand, service quality can be conceptualized as a function of the differences between customer’s expectation and performance along the quality dimensions [17]. Thus, user-based definition of quality is the most complex definition of quality.

Manufacturing-Based View: This view defines quality as conformance to requirements specification in which the requirements are stated mostly in technical terms. According to Gilmore, “*Quality is the degree to which a specific product conforms to a design or specification*” [18]. This view is based on the idea that any deviation from the specification decreases quality. Similarly as product-based view, manufacturing-based view defines quality in objective and measurable terms, however, focuses on making error-free products or services but not on the absence or presence of some attributes. Sometimes this view is called quality of conformance [12]. Even though it does not ignore the user’s interest in quality, it assumes that this interest can be satisfied if the product is properly constructed. The aim is that a product would be constructed “right the first time” and in such way reworking costs would be eliminated or, at least reduced [10]. Manufacturing-based view assumes that errors can be eliminated by conformance to process standards and concentrates on engineering and manufacturing practices. It assumes also that product quality can be incrementally improved by improving the process. It is supported by ISO 9001 [19] standard and CMM [20]. However “*process standards guarantee only uniformity of output and may thus institutionalize the production of mediocre or bad products*” [21]. Thus manufacturing-based view concerns about user’s needs or preferences only in case

when they are correctly identified and reflected in requirements specification. In addition, “a conformance-to-specifications definition of quality may be inappropriate for services, especially when a high degree of a human contact is involved” [15].

Value-Based View: This view defines quality as the degree of excellence at an acceptable price. It makes a trade-off between cost and quality, that is, it concerns about providing as much quality as the customer is willing to pay for. The quality thing is one that performs or conforms at an acceptable cost or price [22]. However, according to Garvin,

“The difficulty in applying this approach lies in its blending of two related but distinct concepts. Quality, which is measure of excellence, is being equated with value, which is a measure of worth. The result is a hybrid – “affordable excellence”- that lacks well-defined limits and is difficult to apply in practice” [3].

On the other hand, Boehm argues that

“...it is also hard for a value-neutral approach to provide guidance for making its products useful to people, as this involves dealing with different people’s utility functions or value propositions. It is also hard to make financially responsible decisions using value-neutral methods” [23].

Boehm’s view is supported also by [10] and many other researchers.

Defining quality as value, it is necessary to consider both the internal conformance to specifications (manufacturing-based view) and the extent to which user expectations are met (user-based view). A quality model for value based approach has been proposed by Gale [24]. Approaches to customer value measurement have been investigated in [25]. In the context of web services, the Value-Based View can be described by triangle of cost versus functionality versus time to deliver. It means that it is possible to satisfy two of these three factors, but not all three [26].

In summary we can conclude that the concept of quality has multiple and sometimes even muddled definitions, describes a wide variety of phenomena and that meaning of the concept depends on the context and even the time period in which it has been examined. However, new definitions of quality have not replaced old ones. All they continue to be used today. Besides each definition has some strengths and weaknesses and no one is better as others in every situation or context. Consequently, it is impossible to build unique ontological model of the quality in general because we are dealing not with one concept but with the bundle of related concepts. This conclusion is also supported by Reeves and Bednar [15].

2. What Means the Quality of Service?

All early definition of quality, up to ‘70s of twentieth century, services were not explicitly addressed and even later, up to end of twentieth century, most researchers continued to focus on product quality. However in this same time in research works on marketing the attempts have been done to understand and define quality in both manufacturing and service organizations [15]. It was pointed out that, although services and products share many similarities, they differ also in a number of ways: 1) services are intangible, cannot be stocked, and their attributes are difficult to demonstrate (intangibility); 2) services are heterogeneous and it is their fundamental characteristic because results of service varies from day-to-day or from customer-to-customer and of this reason it is hard to standardize their quality (heterogeneity); 3) services are inseparable because to a large extent, they are simultaneously produced and consumed (inseparability); 4)

services are extremely perishable, that is, they have zero inventory, cannot be saved for later use, can be used only once else they perish and once sold, they stand sold and cannot be returned (perishability). In addition, a service is a process rather than a thing and consumer's involvement in the production of many services creates additional quality control difficulties for managers. In research literature, above mentioned four services characteristics usually are referred as IHIP characteristics [27]. Although some criticism exists whether services are really different from goods and whether the IHIP characteristics are characterizing services, today, the service concept is operationalized mainly through these characteristics [28]. Even more complicated is the question whether or not existing service concepts, including IHIP characteristics and definitions of quality, are applicable to internet services. Conflicting opinions exist on these issues. For example, Moeller argues that:

“The characteristics of intangibility, heterogeneity, inseparability, perishability (IHIP) that have been regularly applied to services have been subjected to substantial criticism, as more and more exceptions occur. The reasons for the criticism are twofold. The focus of services marketing has changed and the development of information and communication technology has advanced dramatically” [27].

Edvardsson et al. [28] and many other researchers advocate also that technology-based services are, in fact, storable, repeatable, often standardized and last, but not least; the service production does not involve any direct interactions with humans. On the other hand, Hofacker et al. [29] states that e-services are less tangible as traditional services, possible, more heterogeneous, taking into account instability of hardware, software and network environment, highly flexible in terms of physical separation between consumer and producer, and can be stored indefinitely by the provider (on server disk) or user. According to [4], majority of papers written on the topic of internet service quality discuss technical details how to pass information about service quality paying little attention to the meaning of quality itself. However it is obvious that every such context-dependent definition should be compatible with the definition of quality in general as well as with universal software quality model. In [4] authors argue that web service quality model should be based on SQuaRE model for software [30]. They define Quality of Web Service as *“ability of Web Service to provide specific users with specific service in defined context of use”* (user-based view of quality), propose to consider also internal web service quality (manufacturing-based view of quality) and external web service quality (product-based view of quality), and suggest that quality of web service composition should be evaluated taking into account hardware, software environment, service itself and transportation quality characteristics for each candidate service.

3. Conclusions

The analysis of the concept QoS demonstrated that this concept is ambiguous and difficult to define precisely. Although observations that have been made in [4] are very significant and highlight some aspects of the nature of this concept, unfortunately, they are still not enough to develop the ontological model of QoS and more deep analysis of QoS should be done for this aim. It is the aim of our further research.

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